THURSDAY, JUNE 2, 1887.

THE PRE-HISTORY OF THE NORTH.

The Pre-History of the North, based on Contemporary Memorials. By the late Chamberlain J. J. A. Worsaae, &c. Translated, with a brief Memoir of the Author, by H. F. Morland Simpson, M.A. (London: Trübner and Co., 1886.)

IT was a happy thought to offer as a tribute of respect to the memory of one who had done so much for English history and archæology as the late Mr. Worsaae, an English translation of one of the latest, as well as one of the most important, of his archæological essays. The Danish original, of which the volume before us is a translation, is prefaced by an introduction dated December 1880, but a still later work of Worsaae's, and one which may practically be regarded as his last, required no translation, as it was originally written by him in the English language, and published in 1882. This work is entitled "The Industrial Arts of Denmark, from the Earliest Times to the Danish Conquest of England," and forms one of the series of hand-books issued in connexion with the South Kensington Museum. A fellow volume on "The Industrial Arts of Scandinavia in the Pagan Time" appeared in 1883 from the pen of Dr. Hans Hildebrand, of Stockholm.

But not only did one of Worsaae's latest works make its first appearance in the English tongue, but thirty years previously, in 1852, one of his earliest works—indeed one of his most important independent works—appeared in an English garb almost at the same time as it did in the Danish and German languages. This, his "Account of the Danes and Norwegians in England, Scotland, and Ireland," was partly the result of a lengthened stay in the British Isles, and contains a vast store of historical information, to which perhaps too little recourse has been had by English students. It was, however, as an archæologist rather than as an historian that Worsaae merited and obtained the highest distinction. A remarkable linguist, a man of high organizing power, of indefatigable industry, and endowed with the most amiable disposition and the most charming manners, the record of all that he was able to accomplish is absolutely amazing. At the age of eighteen he had already begun to write on archæological subjects, and his important work on the "Primæval Antiquities of Denmark," written by him at the age of twenty-two, and published in 1843, was translated into English by the late Mr. Thomas, and published in 1849. From that date to the day of his death his pen was never idle. This, however, is not the place to attempt an account of Worsaae's contributions to archæology. They have already been recorded by Dr. Sophus Müller in the *Mémoires* of the Society of Northern Antiquaries. Those who, from time to time, have attended the Congresses of Prehistoric Archæology and Anthropology will have been able to form some idea of the versatility of Worsaae's mind and the vast extent of his archæological acquirements; and those who have visited the Museum of Northern Antiquities and the Rosenborg Castle at Copenhagen will have been impressed with his wonderful powers of organization and arrangement. The formation of an historical museum like that of Rosenborg was the result of a happy inspiration, and the difficulties that attended it were by no means slight. Worsaae's own account of them in his "Optegnelser om Rosenborg-Samlingen i 25 Aar" is of the highest interest, though perhaps it would have been wise on the part of his executors to have postponed the publication of this autobiographical memoir for a few years. His relations to the Court of two successive Kings of Denmark were of an intimate kind, and occasionally great tact had to be exercised in carrying out his views as to the requirements of the Rosenborg Museum, which illustrates in such a remarkable manner the successive reigns of the Danish monarchs from the fifteenth century downwards. The estimation in which he was held in his own country was evinced in 1874 by his being appointed Minister of Worship and Public Instruction, but, fortunately for archæological science, his tenure of office was not of long duration.

It is, however, time to turn more immediately to the work the title of which heads this notice. Its object is to trace the prehistoric settlements and the development of civilization in the Scandinavian North; and the phases under which these are considered, and the approximate chronology assigned to them are as follows:—

I. The early Stone Age, at least 3000 B.C., when portions only of Southern Scandinavia seem to have been inhabited.

II. The later Stone Age, about 2000 to 1000 B.C., contemporaneous with the Bronze Age on the shores of the Mediterranean.

III. The early Bronze Age, about 1000 to 500 B.C., when a Stone Age existed to the north, and an Iron Age had already come in to the south.

IV. The late Bronze Age, about 500 B.C. to the time of Christ's birth, when a pre-Roman Age of Iron was developed in Central and Western Europe.

V. The early Iron Age, from A.D. 1 to 450, when bronze was still in use in parts of the Scandinavian peninsula.

VI. The middle Age of Iron, about A.D. 450 to 700, when foreign Romano-German influence predominated.

VII. The later Iron Age, or Viking Period, about A.D. 700 to 1000, when a Stone Age still lingered in the extreme north of Finland and Lapland.

The characteristic relics of all these stages of culture are discussed, and their extension in time and space and the sources whence the various phases of civilization were more immediately derived to the north are indicated With regard to these general considerations not much need be said, unless it be to observe that, with regard to the Danish shell-mounds, or Kjökken-möddings, all antiquaries and naturalists are not of one accord in assigning to them an antiquity beyond that of the ordinary forms of polished stone implements.

Two principal points on which Worsaae insists are the religious origin of many of the deposits of prehistoric periods, and the religious signification of many symbols, which at first sight would seem to be but of a conventional character. The two remarkable golden horns found in 1639 and 1734 at Gallehus, in Slesvig, buried but a few yards apart, belonged apparently to the middle Iron Age;

and though they were stolen and melted down in 1802, faithful representations of them have been preserved. The horns were divided by projecting rings into a series of compartments, in nearly all of which there were groups of human and animal figures accompanied by various symbols. The meaning of these, Worsaae, by the light of northern mythology, has undertaken to interpret; and though it is impossible here even to attempt to reproduce his interpretation, it may fairly be said that it is one that commends itself for its consistency, and which the correspondence between the subjects on the two horns tends strongly to corroborate. There can, as he says, be scarcely a doubt that these gold horns, unique both in size and embellishment, originally formed a pair, and that, like other heathen representations in metal, stone, bone, or wood, they were a sort of sacred picture-book kept in a temple and intended to preserve the kernel of the old theology for the people. Accepting the view of certain marks and symbols being especially those of Thor, Odin, Frey, and other divinities, it is found that not only in later times did the Northmen cling with tenacity to their ancestral reverence for the images and sacred marks of their gods, but that in early times, even in the Bronze Age, traces may be discovered of similar objects of reverence, and that the whole system of northern mythology, such as it existed at the time of its supersession by the Christian faith, was but the development of religious ideas that had subsisted in the same regions in remote prehistoric times. Some speculations with regard to these sacred signs will also be found in our author's "Danish Arts" (p. 65 *et seq.*, p. 114).

The same may be said as to his views with regard to many of the deposits of arms and implements, both of stone and bronze, having originated from religious motives ("D. A." p. 63). It is certainly the case that considerable hoards of large flint axes, crescent-shaped knives of flint, and lance- or spear-heads of the same material, have been found deposited under large stones in fields and bogs, the uniformity of the objects in the deposit raising a presumption that it was not due to the mere hiding away of the private property of one individual, but rather to the fact that some offering to the gods was intended. In the case of hoards of bronze objects, there are some which comprise lumps of rough metal, old and worn-out inplements, and even moulds. Such must, with all probability, be regarded as the property of bronze founders, hidden in the ground for the sake of security, and, from some cause or other, never afterwards recovered by the owners. There are, however, other deposits which, like those of stone already mentioned, would appear to have been due to a religious motive. In some instances the objects have been purposely broken and rendered useless, in the same manner as the gold Gaulish coins found in the Seine, which appear to have been offerings to the *Dea Sequana*, have been so constantly defaced. Such offerings to the divinities of springs and rivers were not unfrequent in Roman times, and continued in vogue even in later ages. The subject of the religious rites of the early prehistoric ages is, then, one the investigation of which has been fairly started by Worsaae, and offers a field in which future research may profitably be prosecuted.

The meaning and derivation of the devices on Scandinavian bracteates, which to a certain extent correspond with the *bullæ* of the Romans, is also discussed in the book before us, which, though extending to little more than 200 pages, contains the result of much thought on the part of the author, and is suggestive of much more for the attentive reader.

It remains to say a few words with regard to the translator, who on the whole has done his work in a satisfactory manner, though probably a more intimate acquaintance with the Danish language and with Scandinavian archæology would have been advantageous. Such terms as grave-heights for barrows, or grave-mounds, and the mention of a Society of Ancient Northern Texts, and the account of a discovery of relics of a primitive Stone Age in ancient chalk deposits under the earth's surface might have been avoided. But the most provoking part of the book is the author's or printer's misplaced economy in the matter of commas. Such a sentence as the following may serve as an example (p. 146): "Many other objects have been discovered in bogs and fields as well as in skeleton-graves from the close of the early Iron Age and from the middle Iron Age in Denmark, as for instance an angel of gold in deacon's robes an armlet with Christian symbols a ball of crystal a jewel carved with Christian Gnostic inscriptions in Greek ("Ablanathanalba," *i.e.* Thou art our Father) brooches mountings with barbarized semi-Christian ornaments, known also in other countries, and many others." But with all these slight defects the work of Worsaae still retains its full value, and English archæologists should gladly welcome its appearance in what Prof. Stephens, of Copenhagen, would call their "mother-tung."

JOHN EVANS.

PROFESSOR STOKES ON LIGHT.

Burnett Lectures. Third Course: On the Beneficial Effects of Light. By G. G. Stokes. (London: Macmillan and Co., 1887.)

THIS volume completes the course of the First Burnett Lecturer on the New Foundation. We have already (vol. xxix. p. 545, and vol. xxxii. p. 361) noticed the first two volumes; and we are now in a position to judge of the work as a whole. But we must first speak of the contents of the present volume.

The author commences by extending the term "Light" to radiation in general, and proceeds to a consideration of the effects which (unlike vision) are not merely beneficial to living things, whether plants or animals, but absolutely essential to their existence. Here, so far at least as matters suitable for an elementary work are concerned, there is not much room for novelty:—for the subject has of late been pretty well threshed out by various writers. Still, the mode of treatment adopted is of interest, especially that of marshalling our reasons for regarding all forms of radiation as due to one and the same agent.

"When we stand by some mighty waterfall, such for example as Niagara, and are struck by the grand exhibition of power that we see before us, we do not perhaps reflect that while it is through light that we are enabled to see what is going on, it is from light also that the energy is derived that we thus see in action."

Next comes a curious suggestion of analogy between the behaviour of fluorescent bodies (which always *degrade* the refrangibility of the light they give off) and the heat-radiation from bodies which have been exposed to sunlight. Sunlight, as it reaches us after passing through the atmosphere, is less rich in ultra-red rays than is the radiation from the majority of terrestrial sources; while the radiation from bodies which have been heated by direct sunlight is entirely ultra-red. Here we have, for the terrestrial atmosphere, the "green-house theory" which, in the second course, was applied to explain some of the singular phenomena exhibited by comets.

This is followed by an extremely interesting discussion of the functions of the colouring-matters of blood and of green leaves:—with the contrasted effects, upon plants, of total deprivation of light, and of continuously maintained illumination. A particularly valuable speculation, as to the probable nature of the behaviour of chlorophyll, is unfortunately too long for extraction.

So far, radiation has been treated without any special reference to vision. But the author proceeds to describe the physical functions and adaptations of the eye:—with particular reference to the arrangements for obviating such of the theoretical defects as, while involved in its general plan, *would also tend to diminish its practical usefulness.* The introduction of this obviously natural proviso, one which we do not recollect having seen prominently put forward till now, exhibits in a quite new light the intrinsic value of those objections to the "argument from design" which have been based upon the alleged imperfection of the eye as an optical instrument.

The analogy of fluorescence is once more introduced, but now for the purpose of suggesting a mechanical explanation of the mode in which the sense of vision is produced. This is brought forward after the modern photo-chemical theory of vision has been discussed. The latter is not altogether dismissed as improbable, but some of the more important difficulties which it raises are pointed out. The triplicity of the colour-sense, and the mechanism of single vision with two eyes, are treated at some length. But throughout this part of the work it is frankly confessed that there are many elementary questions, some of fundamental importance, which we are still unable even approximately to answer.

In his final chapter, the lecturer, in conformity with the terms of his appointment, discusses the *argument from design.* The origin of life, and the origin of species, are boldly (though all too briefly) treated:—next comes the question of the adaptation of physical structure, specially of course that of the eye, to the modes of life and the wants of animals.

"There is some very intimate connection between thinking, as we know it in ourselves, and the condition of the brain. So close is the connection that some have supposed that thinking is a mere function of the material organism, conditioned by nothing more than the motions of the molecules of which that organism consists. But surely this is going far beyond a legitimate inference from the observed facts. The body of a living animal is obedient to the laws of motion, the law of gravitation, and similar laws of the kind which belong to dead matter. But that does not prove that life is nothing more than a process depending on such laws. So if thinking be accompanied, as we know it in ourselves to be accompanied, by a state of activity of the material organism of which the body consists, that does not prove that thinking is nothing more than an action of the material organism. We have seen that life can only proceed from the living; may it not be in a similar manner that mind can only proceed from that which has mind? See what the contrary supposition leads us to. Here is man, in a geological sense a creature but of yesterday, utterly incapable of accounting for his own existence by any play of mere natural forces, and yet ignoring the existence of any mind higher than his own mind, though ready enough to admit the existence of unintelligent law, and that without limitations of time or space."

No higher praise need be bestowed on the scientific part of this third volume than is involved in saying that it is a worthy successor to the other two. Together, they form a singularly instructive, and yet (in the best sense) popular, treatise on a fascinating branch of natural philosophy. Were this their only aim, no one could deny that it has been thoroughly attained.

But their aim is of a loftier character. Here and there throughout the work there have been occasional references to the main purpose which has determined the author's mode of arranging his facts and his deductions from them. In the few closing pages this purpose is fully developed, and a brief but exceedingly clear statement shows at once how much in one sense, and yet how little in another, can be gathered as to the personality and the character of the Creator from a close and reverent study of His works.

These closing pages point out distinctly the danger alike of totally neglecting, and of too exclusively studying, the grandeur of nature. The first holder of this new post has set a noble example to his successors. He has supplied, not only to them but also, and we hope especially, to the rapidly-changing quaternion of neo-teleologists who will soon be set at work in the Scottish Universities, a warning which they will do well to lay to heart:—

"If we confine our attention to the study of nature in all its immensity, our conceptions of its Author are in danger of merging in a sort of pantheistic abstraction, in which the idea of personality is lost."

P. G. TAIT.

OUR BOOK SHELF.

Our Bird Allies. By Theodore Wood. (London: Society for Promoting Christian Knowledge, 1887.)

THE author of this little book holds that no British bird is utterly and wholly destructive, but that the misdeeds of even the most mischievous are atoned for in some degree by services rendered to us in other ways. Birds aid us, he points out, in three ways—first, by acting as scavengers, and destroying putrid matter; secondly, by devouring the seeds of the various wild plants which are so troublesome upon cultivated land; thirdly, and most important, by the slaughter of insects. The limitations of space have prevented Mr. Wood from mentioning all the birds he would have liked to describe, but he has found room for an account of most of the British birds which are especially beneficial. He writes simply, clearly, and with adequate knowledge; and there are probably few farmers who would not profit by studying what he has to say on a subject in which they ought to be strongly interested. He expresses his firm conviction that agriculture, as a profitable undertaking, is absolutely

dependent upon the preservation of the "feathered race," and in support of this opinion he has brought together much solid evidence. Two of the best chapters in the book are on the sparrow, which he admits to be, during harvest, an unmitigated nuisance. He thinks, however, that even at such times "the farmer best consults his own interests by merely scaring the bird away in place of destroying it, and that sooner or later he will reap his reward for his wise forbearance."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Thought without Words.

THE following correspondence has passed between Prof. Max Müller and Mr. F. Galton with reference to Mr. Galton's letter on "Thought without Words," printed in NATURE on May 12 (p. 28):—

All Souls' College, Oxford, May 15, 1887.

DEAR MR. GALTON,—I have to thank you for sending me the letter which you published in NATURE, and in which you discuss the fundamental principle of my recent book on the "Science of Thought," the identity of language and reason. Yours is the kind of criticism I like—honest, straightforward, to the point. I shall try to answer your criticism in the same spirit.

You say, and you say rightly, that if a single instance could be produced of a man reasoning without words, my whole system of philosophy would collapse, and you go on to say that you yourself are such an instance, that you can reason without words.

So can I, and I have said so in several passages of my book. But what I call reasoning without words is no more than reasoning without pronouncing words. With you it seems to mean, reasoning without possessing words. What I call with Leibniz, symbolic, abbreviated, or hushed language, what savages call "speaking in the stomach," presupposes the former existence of words. What you call thinking without words seems to be intended for the thinking of beings, whether men or animals, that possess as yet no words for what they are thinking.

Now let us try to understand one another; that is to say, let us define the words we are using. We both use thinking in the sense of reasoning. But thinking has been used by Descartes and other philosophers in a much wider sense also, so as to include sensation, passions, and intuitive judgments, which clearly require no words for their realization. It is necessary therefore to define what we mean by thinking, before we try to find out whether we can think without words. In my book on the "Science of Thought" I define thinking as addition and subtraction. That definition may be right or wrong, but every writer has the right, nay the duty, I should say, to explain in what sense he intends to use certain technical terms. Though nowadays this is considered rather pedantic, I performed that duty on the very first page of my book, and it seems somewhat strange that a reviewer in the *Academy* should accuse me of not having defined what I mean by thinking, for most reviewers look at least at the first page of a work which is given them to review.

Now, the cases which you mention of wordless thought are not thought at all in my sense of the word. I grant that animals do a great deal of work by intuition, and that we do the same, nay that we often do that kind of work far more quickly and far more perfectly than by reasoning. You say, for instance, that you take pleasure in mechanical contrivances, and if something does not fit, you examine it, go to your tools, pick out the right one, set to work and repair the defect, often without a single word crossing your mind. No doubt you can do that. So can the beaver and the bee. But neither the beaver nor the bee would say what you say, namely that in doing this "*you inhibit any mental word from presenting itself.*" What does that mean, if not that the mental words are there, the most complicated thought-words, such as *tool, defect, fit*, are there? only you do not pronounce them, as little as you pronounce "two shillings and sixpence," when you pay a cabman half-a-crown.

The same applies to what you say about billiards and fencing. Neither cannoning nor fencing is thinking. The serpent coiling itself and springing forward and shooting out its fangs does neither think nor speak. It sees, it feels, it acts, and as I stated on p. 8 of my book, that kind of instantaneous and thoughtless action is often far more successful than the slow results of reasoning. Well do I remember when I was passing through my drill as a Volunteer, and sometimes had to think what was right and what was left, being told by our sergeant, "Them gentlemen as thinks will never do any good." I am not sure that what we call genius may not often be a manifestation of our purely animal nature—a sudden tiger's spring, rather than *une longue patience.*

It is different, however, with chess. A chess-player may be very silent, but he deals all the time with thought-words or word-thoughts. How could it be otherwise? What would be the use of all his foresight, of all his intuitive combination, if he did not manipulate with king, queen, knights, and castles? and what are all these but names, most artificial names too, real agglomerates of ever so many carefully embedded thoughts?

An animal may build like the beaver, shoot like the serpent, fence like the cat, climb like the goat; but no animal can play chess, and why? Because it has no words, and therefore no thoughts for what we call king, queen, and knights, names and concepts which we combine and separate according to their contents; that is, according to what we ourselves or our ancestors have put into them.

You say, again, that in algebra, the most complicated phase of thought, we do not use words. Nay, you go on to say that in algebra "*the tendency to use mental words should be withstood.*" No doubt it should. The player on the pianoforte should likewise withstand the tendency of saying, now comes C, now comes D, now comes E, before touching the keys. But how could there be a tendency to use words, or, as you say in another place, "*to disembarrass ourselves of words,*" if the words were not there? In algebra we are dealing, not only with words, but with words of words, and it is the highest excellence of language if it can thus abbreviate itself more and more. If we had to pronounce every word we are thinking, our progress would be extremely slow. As it is, we can go through a whole train of thought without uttering a single word, because we have signs, not only for single thoughts, but for whole chains of thoughts. And yet, if we watch ourselves, it is very curious that we can often feel the vocal chords and the muscles of the mouth moving, as if we were speaking; nay, we know that during efforts of intense thought, a word will sometimes break out against our will; it may be, as you say, a nonsense word, yet a word which, for some reason or other, could not be inhibited from presenting itself.

You say you have sometimes great difficulty in finding appropriate words for your thoughts. Who has not? But does that prove that thoughts can exist without words? Quite the contrary. Thoughts for which we cannot find appropriate words are thoughts expressed as yet by inappropriate, very often by very general, words. You see a thing and you do not know what it is, and therefore are at a loss how to call it. There are people who call everything "that thing," in French "*chose*," because they are lazy thinkers, and therefore clumsy speakers. But even "thing" and "*chose*" are names. The more we distinguish, the better we can name. A good speaker and thinker will not say "that thing," "that person," "that man," "that soldier," "that officer," but he will say at once "that lieutenant-general of Fusiliers." He can name appropriately because he knows correctly, but he knows nothing correctly or vaguely except in a string of names from officer down to thing. Embryonic thought, which never comes to the birth, is not thought at all, but only the material out of which thought may spring. Nor can infant thought, which cannot speak as yet, be called living thought, though the promise of thought is in it. The true life of thought begins when it is named, and has been received by baptism into the congregation of living words.

You say that "after you have made a mental step, the appropriate word frequently follows as an echo; as a rule, it does not

accompany it." I know very well what you mean. But only ask yourself what mental step you have made, and you will see you stand on words ; more or less perfect and appropriate, true ; but nevertheless, always words. You blame me for having ignored your labours, which were intended to show that the minds of everyone are not like one's own. You know that I took a great deal of interest in your researches. They represented to me what I should venture to call the dialectology of thought. But dialects of thought do not affect the fundamental principles of thinking ; and the identity of language and reason can hardly be treated as a matter of idiosyncrasy.

You also blame me for not having read a recent book by Monsieur Binet. Dear Mr. Galton, as I grow older I find it the most difficult problem in the world, what new books we may safely leave unread. Think of the number of old books which it is not safe to leave unread ; and yet, when I tell my friends that in order to speak the *lingua franca* of philosophy, they ought at least to read Kant, they shrug their shoulders, and say they have no time, or, *horribile dictu*, that Kant is obsolete. I have, however, ordered Binet, and shall hereafter quote him as an authority. But who is an authority in these days of anarchy? I quoted the two greatest authorities in Germany and England in support of my statement that the genealogical descent of man from any other known animal was as yet *unproven*, and I am told by my reviewer in the *Academy* that such statements "deserve to be passed over in respectful silence." If such descent were proved, it would make no difference whatever to the science of thought. Man would remain to me what he always has been, the perfect animal ; the animal would remain the stunted man. But why waste our thoughts on things that may be or may not be? One fact remains, animals have no language. If, then, man cannot think, or, better, cannot reason, without language, I think we are right in contending that animals do not reason as man reasons ;—though, for all we know, they may be all the better for it.

Yours very truly,

F. MAX MÜLLER.

Francis Galton, Esq., F.R.S.

42 Rutland Gate, S.W., May 18, 1887.

DEAR PROFESSOR,—Thank you much for your full letter. I have not yet sent it on to NATURE because it would have been too late for this week's issue, and more especially because I thought you might like to reserve your reply, not only until you had seen my own answer to what you have said in it, but also until others should have written, and possibly also until you had looked at Binet, and some of the writers he quotes. So I send you very briefly my answer, but the letter shall go to NATURE if you send me a post-card to send it.

In my reply, or in any future amplification of what is already written, I should emphasize what was said about fencing, &c., "*with the head*," distinguishing it from intuitive actions (due, as I and others hold, to inherited or personal habit).

The inhibition of words in the cases mentioned was, I should explain, analogous to this :—There are streets improvements in progress hereabouts. I set myself to think, by mental picture only, whether the pulling down of a certain tobacconist's shop (*i.e.* its *subtraction* from the row of houses in which it stands) would afford a good opening for a needed thoroughfare. Now, on first perceiving the image, it was associated with a mental perception of the *smell* of the shop. I inhibited that mental smell because it had nothing to do with what I wanted to think out. So words often arise in my own mind merely through association with what I am thinking about ; they are *not* the things that my mind is dealing with ; they are superfluous and they are embarrassments, so I inhibit them.

I have not yet inquired, but will do so, whether deaf-mutes who had never learnt words or any symbols for them, had ever been taught dominoes, or possibly even chess. I myself cannot conceive that the names—king, queen, &c.—are of any help in calculating a single move in advance. For the effect of many moves I use them mentally to record the steps gained, but for nothing else. I have reason to believe that not a few first-rate chess-players calculate by their mental eye only.

In speaking of modern mental literature, pray do not think me so conceited as to refer to my own writings only. I value modern above ancient literature on this subject, even if the modern writers are far smaller men than the older ones, because they have two engines of research which the others wanted :—

(1) Inductive inquiry, ethnological and other. The older authorities had no vivid conception of the different qualities of men's minds. They thought that a careful examination of their own minds sufficed for laying down laws that were generally applicable to humanity.

(2) They had no adequate notion of the importance of mental pathology. When by a blow, or by a disease, or, as they now say, by hypnotism, a whole province of mental faculties can be abolished, and the working of what remains can be carefully studied, it is now found that as good a clue to the anatomy of the mind may be obtained as men who study mangled limbs, or who systematically dissect, may obtain of the anatomy of the body.

I add nothing about the advantage to modern inquirers due to their possession of Darwinian facts and theories, because we do not rate them in the same way.

Very truly yours,

FRANCIS GALTON.

Professor Max Müller.

Oxford, May 19, 1887.

MY DEAR MR. GALTON,—If you think my letter worth publishing in NATURE, I have no objection, though it contains no more than what anybody may read in my "Science of Thought."

Nothing proves to my mind the dependence of thought on language so much as the difficulty we have in making others understand our thoughts by means of words. Take the instance you mention of a shop being pulled down in your street, and suggesting to you the desirability of opening a new street. There are races, or, at all events, there have been, who had no name or concept of shop. Still, if they saw your shop, they would call it a *house*, a *building*, a *cave*, a *hole*, or, as you suggest, a chamber of smells and horrors, but at all events a *thing*. Now, all these are names. Even "*thing*" is a name. Take away these names, and all definite thought goes ; take away the name *thing*, and thought goes altogether. When I say word, I do not mean *flatus vocis*, I always mean word as inseparable from concept, thought-word or word-thought.

It is quite possible that you may *teach* deaf-and-dumb people dominoes ; but deaf-and-dumb people, left to themselves, do not invent dominoes, and that makes a great difference. Even so simple a game as dominoes, would be impossible without names and their underlying concepts. Dominoes are not mere blocks of wood ; they signify something. This becomes much clearer in chess. You cannot move king, or queen, or knight as mere dolls. In chess, each one of these figures can be moved according to its name and concept only. Otherwise chess would be a chaotic scramble, not an intelligent game. If you once see what I mean by names, namely that by which a thing becomes *notum* or known, I expect you will say, "Of course we all admit that without a name we cannot really know anything."

I wonder you do not see that in all my writings I have been an evolutionist or Darwinian *pur sang*. What is language but a constant becoming? What is thought but an *Ewiges Werden?*

Everything in language begins by a personal habit, and then becomes inherited ; but what we students of language try to discover is the first beginning of each personal habit, the origin of every thought, and the origin of every word. For that purpose ethnological researches are of the highest importance to us, and you will find that Kant, the cleverest dissector of abstract thought, was at the same time the most careful student of ethnology, the most accurate observer of concrete thought in its endless variety. With all my admiration for modern writers, I am in this sense also a Darwinian that I prefer the rudimentary stages of philosophic thought to its later developments, not to say its decadence. I have learnt more from Plato than from Comte. But I have ordered Binet all the same, and when I have read him I shall tell you what I think of him.

Yours very truly,

F. MAX MÜLLER.

A Use of Flowers by Birds.

SOME years ago you allowed me to describe in NATURE the pretty doings of a pair of goldfinches, who, having built their nest on a bough overhanging a garden path, proceeded to make it more like the sky above, and therefore less visible from below, by hanging it round with wreaths of forget-me-nots.

This year, in the same garden, some sparrows have shown equal ingenuity. They began a nest in a *Pyrus japonica* against

the white house, whilst the tree was still almost bare of leaves. Not wishing for the noise and dirt so near the windows, I removed it, and they began another; again it was removed, and this time, though apparently little more than a flat beginning, it had eggs upon it. They tried again, and on removing it the third time I found that the birds were overlaying it on all sides with the flowers of some sweet Alyssum that was growing below; the intention being, evidently, to render it more like the background of white wall, and therefore less conspicuous.

Sidmouth. J. M. H.

Earthquakes and the Suspended Magnet.

DURING the afternoon of May 3 at Lyons, N.Y., a peculiar quivering motion of the suspended magnet was noted, especially at about 1 o'clock p.m., and a strong westward deflection continued during the afternoon. Similar phenomena have been noted repeatedly when earthquakes were in progress, in this case the shock being quite severe, and occurring at 3.8 p.m. at El Paso, Texas. M. A. VEEDER.

Lyons, N.Y., May 4.

Units of Weight, Mass, and Force.

THE letter of Prof. Greenhill (NATURE, vol. xxxv. p. 486) is both timely and suggestive. Herbert Spencer's chapter on space, time, matter, motion, and force, supplemented by his chapter on the persistence of force, in "First Principles of Philosophy," gives all that can be desired by the student for a complete comprehension of the subject. One who assimilates the basic truths there so clearly given need never be perplexed by any statement found in the mechanical and mathematical text-books. It is simply impossible to use language in regard to these matters without employing expressions that are true only in a certain sense. We say that "the sun rises" and "the sun sets," and that "the heavens revolve." If these words are used to indicate the cause of the progressive shadows on a sun-dial, or the time of day, they serve a practical need as well as if they were true. But a student who should infer the constitution of the solar system from such phrases would go far astray.

When the significance of Spencer's explanation of motion is grasped, a great part of the ambiguity will have vanished. We constantly think of motion as an entity, which is a pure delusion. We also say of force that it is the cause of motion. Nothing can be more untrue. Force is the cause of change of motion only. There is not a conceivable difference between rest and motion otherwise than as the expression of a relation. Whether a body be at rest or in motion depends wholly upon the body to which it is related.

When the student sees that motion is no entity, and is familiar with the process by which the conceptions of matter, force, space, and time, are built up from sensations, he will be in no danger of mistaking the sense in which certain text-book statements are to be taken, much less will he be captured by those in which the errors are unpardonable. I. LANCASTER.

Chicago, Ill., April 28.

WITH regard to Mr. Geoghegan's letter in your issue of April 7 (vol. xxxv. p. 534), my experience in teaching physics long ago led me to the same conclusions. For three years I have used in my classes in this the oldest existing University in Ontario, and with the greatest advantage, the terms *tach*, *gramtach*, *prem*, and *dyntach* for the units of velocity, momentum, pressure-intensity, and rate of working respectively, in the C.G.S. system of units. These may be found in my "Introduction to Dynamics," which was printed last year for my junior class. *Prem* was chosen after failure to get a euphonious monosyllable from the Greek. A name for the unit of acceleration I have not found to be necessary. *Vel* seems to me to be a good word for the unit of velocity in the F.P.S. system of units, but, for fear of hanging on a sour apple-tree, I would shudder to mention *pound-vel* and *poundal-vel*. The term *squeeze* would be suitable in several respects for a *poundal per square foot*, but in mixed classes, such as we have here, it might lead to disorder.

D. H. MARSHALL.

Queen's University, Kingston, Ontario, Canada, April 27.

Remarkable Phenomenon seen on April 26, 1887.

A PHENOMENON was seen here this evening quite distinct from anything I have before observed. It was an exact copy of streams of aurora borealis rising from a low arch, but instead of being in the northern heavens it was near the south horizon. The sky was cloudless, except a long thundercloud which extended from near south-south-west to almost south-south-east, the upper portion of this cloud being about 12° above the horizon. From this cloud issued from one to three streams of conspicuous white light, the north-easterly stream being the largest and brightest, and this continued visible from 9.40 until 10.5 (the others were only seen for five minutes). The streams were at an angle of about 53°, and moved slowly easterly (the cloud moving in the same direction). The longest stream reached an altitude of 25°, and at 10 o'clock exactly (G.M.T.) the base was immediately over the Avonmouth Lighthouse. The light of the streams was more persistent and less flickering than is usually the case with aurora borealis.

There was also a confused luminosity behind the cloud, which varied considerably in brightness; this made the outline of the cloud at one time distinctly visible, and at another scarcely discernible; this also gave the clouds a black appearance. After 10 p.m. other clouds rose above the cumulo-stratus, and the streams became hid. Three hours afterwards there was a snow-storm, and the ground was white till 7 a.m. Reports from Somerset, Dorset, and Devon would be valuable.

Shirenewton Hall, near Chepstow. E. J. LOWE.

Pear-shaped Hailstones.

ARE pear-shaped hailstones as uncommon as some of your correspondents suppose?

We have had here to-day a succession of heavy showers of rain and hail together, the hailstones being small, but many of them pear-shaped, and the rest of shapes which might easily have been derived from that form by attrition or partial melting.

About half-past six this evening we had a storm of hail only, heavier than any that preceded it, in which nearly or quite all the stones were pear-shaped, from a fifth to a third of an inch in diameter. B. WOODD SMITH.

Penmaenmawr, N. Wales, May 20.

P.S.—May 21. At 9.30 this morning we had another shower of hail and rain, in which the stones showed no sign of any pear-shape, but were of irregular rounded forms.

"A Junior Course of Practical Zoology."

IN the review of Messrs. Marshall and Hurst's book referred to in my friend Prof. Bourne's letter, I sought to compare that work with others devoted to the familiar type-system, to which alone the words "all other books current" were meant by me to refer, to the exclusion of general text-books such as those from which he quotes. I admit that I might have made my meaning somewhat plainer than I did, and would beg to be allowed to state that I had it in my mind, at the time of writing, to refer the reader to the impartial statements made on the subject in question by Prof. Rolleston in his "Forms of Animal Life"; the first of the series of what we are now pleased to term "type" or "junior course" books.

With respect to my critic's second objection, I would ask the readers of NATURE to judge for themselves how far the quotations which he so skilfully weaves into his letter do justice to my contention. His view is, like my own, but an expression of opinion, and time alone can show which of the two will come nearest the truth. G. B. H.

South Kensington.

Bishop's Ring.

THE letter by Prof. G. H. Stone in NATURE, vol. xxxv. p. 581, is interesting, as showing the disappearance of "Bishop's ring" in Colorado. It has not wholly disappeared here, being still plainly visible about sunset. In the middle of the day, however, I have rarely seen any trace of its red colour since May last year; but up to that time, although growing much fainter, it was still frequently plain here, and I also saw it in the south of England, both in May and June 1886, but only feebly. Since then, when there has been a slight tinge of red, it has usually

appeared of a dirty brown colour, very different from what "Bishop's ring" used to be, and I have thought that often it has not been in the upper atmosphere, but at a lower altitude, and most visible when there has been more or less smoke; so that it seemed not improbable the smoke was the cause of it. Has anyone else noticed such a phenomenon connected with smoke? "Bishop's ring," as still seen at sunset, is evidently not caused by smoke, but doubtless arises from the same circumstances as made it so conspicuous an object at its first appearance in November 1883, and gradually less so since.

The whitish wisps occurring in and near the ring about sunrise and sunset continued visible at intervals, and varying greatly in distinctness, up to the 31st ult. I have not seen them since, but they have been invisible for longer periods before.

T. W. BACKHOUSE.

Sunderland.

A REVIEW OF LIGHTHOUSE WORK AND ECONOMY IN THE UNITED KINGDOM DURING THE PAST FIFTY YEARS

I.

IT may be useful to recapitulate very briefly the various steps of progress in this important branch of engineering and optical enterprise since the beginning of the Queen's reign. And a few words may be added on the statistics and economics of the subject.

A lighthouse or lightship is naturally to be considered under four heads: (1) tower or hull and its lantern; (2) optical apparatus and its mechanical accessories; (3) lamps and illuminants; (4) auxiliary sound signals.

In 1837 a high degree of excellence had been attained in the first division, at least as regards stone towers and wooden vessels, but in the others *stare super antiquas vias* was a practice largely submitted to. The number also of established lights was comparatively small, about seventy of all kinds being in England and Wales, less than one-fifth of the present number. France, where there had been from 1824 to 1827 an active movement in the direction of coast illumination, possessed in 1836 about 100 lights. In 1822, and again in 1834 a Parliamentary Committee had inquired into the character and management of our lighthouses, with results to be noticed by and by.

In 1837 the old working Phari of Greece, Carthage, and Rome, from Alexandria to the Pillars of Hercules, had long since disappeared, leaving only a few vestiges, chiefly on the shores of France, Spain, and Britain. Of modern times the most notable towers were, on the Continent, the imposing Cordouan at the mouth of the Garonne (1610), and the tourist-haunted Lanterna of Genoa, the latter still being the tallest lighthouse structure in the world; while at home Smeaton's Eddystone (1759), prototype of British towers, the Bell Rock (1811), the Tuskar (1815), and the Carlingford, on Haulbowline Rock (1823), stood as the most striking examples of such edifices. But in 1838 the great tower of Skerryvore was begun by Alan Stevenson, whose father, Robert, had built the Bell Rock Lighthouse. These accomplished engineers have respectively left a graphic and instructive narrative of their work, which may be fitly classed with Smeaton's memorable account of the third Eddystone.

Skerrymhore or Skerryvore (*ysgar-mawr* = great divided cliff, or rocky islet, as in *scar*, or the hills Skerid Fawr, and Skerid Fach) is a nearly submerged reef adjacent to the Island of Tyree, exposed to the full force of the Atlantic, and surrounded by innumerable rocky points constituting "foul ground" along a line of seven miles. It is thus perhaps the most dangerous of all the *skerries* in British waters, and differs essentially from the Eddystone, which, though formidable in itself, rises from the deep sea, and can be approached more nearly in calm weather. Obviously, then, the 72 feet of elevation of the Eddystone lantern-centre, and even the 93 feet of the Bell Rock, could not afford the necessary range to a light intended to give timely notice to mariners of the outlying perils, and a height of 130 feet was adopted for the Skerryvore edifice, which, permitting one of 150 feet from focal plane to high water, insured a geographical horizon of about fourteen nautical miles, or eighteen miles to a vessel's deck. The mean diameter given to this tower was 29 feet, slightly greater than that of Bell Rock, that of Smeaton's Eddystone being 21 feet. The cubic contents are more than four times those of the Eddystone, and more than double those of Bell Rock. There are ten stories below the lantern, for water, fuel, keepers' rooms, and other purposes. The work was completed early in 1844, after extraordinary difficulties and perils, and it is a splendid monument to the energy and skill of Alan Stevenson. Its cost was £87,000.

Yet perhaps some of the towers of the great nation which charges no dues for its lights, but presents them a noble offering to the world, are fully as remarkable. Minot's Ledge (1859) on the Massachusetts coast, and Spectacle Reef, Lake Huron, are examples. The latter structure was begun in 1871, and, though for an inland water, cost £60,000, the special difficulty having been ice, and the laying, by means of a cofferdam, of the lower courses of masonry on a jagged slope of dolomitic limestone 12 feet under water, and eleven miles from land, like the Eddystone. So in the case of Minot's Ledge Tower, the foundations of which were laid on a rock barely visible at extreme low tide, and in the full swell of the ocean, the distinguished engineer General Alexander was able to secure but thirty hours of work in the first year, and 157 in the second.

The Bishop Lighthouse, on the south-westernmost rock of the Scilly Islands, was completed in 1858 at a cost of £34,560. After a quarter of a century's service it has been found expedient to increase the height, and to erect a more powerful optical apparatus, which will be ready during the present year. Other notable towers of the Trinity House are the Smalls (entrance of Bristol Channel), the Hanois (west end of Guernsey), the Wolf, and the new Longships; all being generally alike in design, and not differing widely in dimensions and cost. The Wolf Tower received its light in January 1870, having been begun in March 1862. It was planned by Mr. James Walker, then Engineer to the Trinity House, but carried out by his successor, Mr., now Sir James, Douglass, and by his brother, Mr. William Douglass. This lighthouse is situated seventeen miles from Penzance, and twenty-three west-north-west of the Lizard. It has a mean diameter of nearly 30 feet, and a total height of 110 feet from high water to lantern-centre, being solid for 39 feet from the base, and containing 44,500 cubic feet of granite, weighing 3300 tons. Each face-stone is dovetailed vertically and also horizontally—the latter was not done in the Eddystone tower—and the courses further secured together by metal bolts. Roman cement was used for the work below water, and Portland cement for that above, the whole mixed with a peculiar granitic sand from a Cornish tin-mine. Very great difficulty, as with all these exposed towers, was experienced in the erection of the Wolf and the new Longships, owing to the terrific seas that assaulted the rocks. The Longships, so conspicuous an object from the Land's End, and so well known from Mr. Brett's luminous pictures, with an original elevation of 79 feet above high water, was so drowned by the waves that the character of the light could hardly be discerned, and a granite column of 110 feet was adopted.

In Scotland the sea-tower of Dubh Artach, or, less correctly, Dhu Heartach (1872), and in the Isle of Man that on the Chicken Rock (1875), may be named and the list of the chief structures of this type may be summed up in the Eddystone of Sir James Douglass, from which a light was first shown in 1882. The rapid disintegration of that part of the reef on which Smeaton's tower stood made it absolutely clear in 1877 that a new tower must be built if a

disaster (such as that which befell the Calf Rock Light a few years later) were to be avoided. It had been suggested to destroy the reef by blasting, as it had been persistently suggested since 1844 to remove the Goodwin Sands. But in either case not only would such a thing be impracticable on account of the enormous expenditure of money and time; but also there is a positive advantage for navigation in retaining a lighthouse or a lightship on these sites. The new Eddystone tower replacing that of Smeaton, which had made the name memorable for 123 years, has an elevation from lantern-centre to high water of 133 feet, commanding a horizon of seventeen and a half nautical miles (to a vessel's deck). The corresponding horizon of the old tower was about fourteen miles, with an elevation of 72 feet. The extended range is ample for all maritime needs. The structure contains 63,020 cubic feet, or 4668 tons, of Cornish and Dalbeattie granite. The tower springs from a solid cylinder of granite about 45 feet in diameter and 20 feet high, set indissolubly on the rock. The mean diameter is about 30 feet. It is solid up to 25½ feet above high water, except as regards space for a water-tank which holds 3500 gallons. It has seven chambers for stores and keepers' use, and a room for exhibiting a small light 15° in azimuth to denote a danger called Hand Deeps. These chambers all have a diameter of 14 feet. There are besides two others below them of less size. Two massive fog-bells are fixed under the lantern-gallery. Very little inflammable material is used. The doors, window-frames, and other fittings are of gun-metal, and every modern resource has been employed to make the building weather-proof and enduring, and to insure the comfort of the three men confined in it, and the unfailing exhibition of the powerful light which crowns it. The time occupied in the work was about three years and a half, the cost less than £80,000.

It is unnecessary to refer to the numerous land towers erected by lighthouse authorities during the half century, because these, being reared for the most part on cliffs, and little exposed to stress of sea, present no difficulty of construction or novelty of type.

All the towers hitherto named are of stone, but iron has not been overlooked as in some circumstances a practicable material for a sea structure. The designs of the late Mr. Alexander Gordon, C.E., in cast and wrought iron, for the towers of several West Indian and South African lights are well worthy of attention, as are also those of Messrs. Grissell for Russia, &c.; and, more recently, the tall iron towers designed and made by Messrs. Chance, of Birmingham, for Australasian sites, are not less remarkable. At home, the Fastnet may be taken as a successful instance of the application of iron. The rock so called is four miles south-west by west of Cape Clear, and has been symbolised as the "Tear-drop of Ireland," being the "last of the old country seen by emigrants." This tower was begun in 1848, and completed in 1853. It is composed of a casing of cast-iron plates with a central column and girder floors, forming five chambers 12 feet high. The lowest story is partly filled in with masonry, leaving space for a coal-vault. The other stories are lined with brick. The internal diameter of the tower is 12 feet, the height from base to gallery 64 feet. The focal plane is 148 feet above the sea. The cost of the work was £19,000. The engineer and designer was the late Mr. George Halpin.

The lightships established in British waters are of great interest. There are now about seventy-five, sixty being on the English coast, of which the larger number date from since 1837. Several of these peculiarly English vessels were placed on their stations in the last century, the historical Nore, for instance, in 1732.

Iron had been in use for light-vessels in the Mersey before 1856. In 1843 it had been discussed by the Trinity House as a possible material, but was not then deemed desirable. The first Trinity iron vessel was stationed in 1857 on the Goodwin Sands, the next in Cardigan Bay in 1860. The usual length of a Trinity lightship is 80 feet when constructed of wood, and about 90 feet when of iron, the width is 21 feet, the average tonnage 155 to 160 tons when of wood, and 180 tons when of iron. The focal plane of a light is generally 38 feet above high water. The cost averages £3600 for wood, and £5000 or £5500 for iron. An immense service is rendered by these modest and vigilant sentinels of the deep which surround our coasts in positions impossible for a lighthouse, and for the most part close to the dangers of which they give warning, or to the channel of approach which they indicate. It has long been proposed to connect these vessels, as also rock and pile lighthouses, with the shore, and (in some cases) with one another, by an electric cable; and a Committee is now engaged on the subject. In this way communications may be made as to the safety and requirements of the station, and as to the passing shipping, and to wrecks and other casualties, though it is doubtful whether reports on the last heads are a proper addition to the functions of a light-keeper, or one that is likely to be satisfactory in the result to the persons concerned.

A curious and ingenious plan of combining the lighthouse with the lightship was conceived by Mr. George Herbert in 1853, and much discussed and recommended at the time. On the assumption that the form of a ship is not the best for a stationary floating body, he proposed a circular vessel, moored from its centre of gravity, and supporting a central tower of about 40 feet high, with lantern, gallery, &c., of the usual kind. A candlestick set in a wash-tub may not be too familiar an illustration. A position north of the Stones Rock, on the Cornish coast, was suggested, at an expense of about £10,000. The Trinity House did not adopt this plan, but in 1859 two beacon buoys on the same principle were successively placed off the Stones, and after a few weeks' service were driven from their moorings and destroyed.

The use of screw piles for the foundation of a lighthouse in sand was first demonstrated at Fleetwood in 1840, and Maplin in 1841, and afterward at the Chapman, Gunfleet, and other stations. The method is that of Alexander Mitchell, improved by Mr. George Wells, who has erected many such structures in various shallow seas.

The lantern, that is the framework of glass and metal, which contains the illuminating apparatus, whether in land or floating lights, has been much modified during the past fifty years. At the accession the lantern of a first-class light was from 10 to 12 feet in diameter, with perhaps 8 feet of glazing in polygonal panes. The bars were heavy and intercepted much light, the ventilation defective, the construction more or less weak and unequal. Successive improvements have been effected by the engineers of the Trinity House and Northern Lights Commission, and by Chance, of Birmingham. In its highest type, that of Sir James Douglass, as in the Bishop Rock example, the lantern of to-day for a first order lighthouse is well worthy of the perfected optical instrument which it protects. It has a diameter of 14 feet between the glass surfaces, a height of glass of 15 feet, and a height from base to vane of about 32 feet. It is cylindrical in form, with solid gun-metal bars, helically inclined and of wedge-like section towards the flame, comprising sixty-four openings of diamond and sixty-four of triangular shape. The polished plate-glass is three-eighths of an inch thick, and bent accurately to fit in these openings. Nine-tenths of the incident light from the lamp is transmitted through this glass. Not more than $\frac{3}{100}$ of light is stopped by the lantern framing. Thus the maximum of stability and the minimum obstruction of the rays are obtained. At the same time every expedient to promote perfect ventilation, from the tubes of Faraday to the longitudinal valves and the roof-cylinders of Douglass, has been adopted, this being indispensable for the combustion of the great

concentric flames now employed. The dome is of rolled copper, the plinth or base of massive cast-iron lined with iron sheets. The cost of such a lantern is about £1700. The lantern of recent lightships has been treated in the same way, having regard to its lightness, mobility, and smaller dimensions. The diameter has been extended to 8 feet, the height of plate-glass to 4 feet, the cylindrical form substituted for every other.

It does not seem possible to construct lighthouse towers and lanterns of better designs and materials than those which have been described. An important amplification of the dimensions may, however, be resorted to in the future to meet the increasing radii of the lenticular apparatus, and the increasing size and height of the central flames. This is on the assumption that electricity does not displace petroleum and gas as illuminants. It may be counted as an additional claim of the arc to be the light of the future that it requires no apparatus larger than Fresnel's first order of 920 millimetres focal distance, and that therefore no lantern exceeding 14 feet in diameter with 10 feet of glazing, and no tower with a diameter of platform greater than 23 feet, would certainly be needed. The merits and prospects of the rival illuminants will be discussed in a subsequent article. J. KENWARD

(*To be continued.*)

CONDENSATION OF GASES.

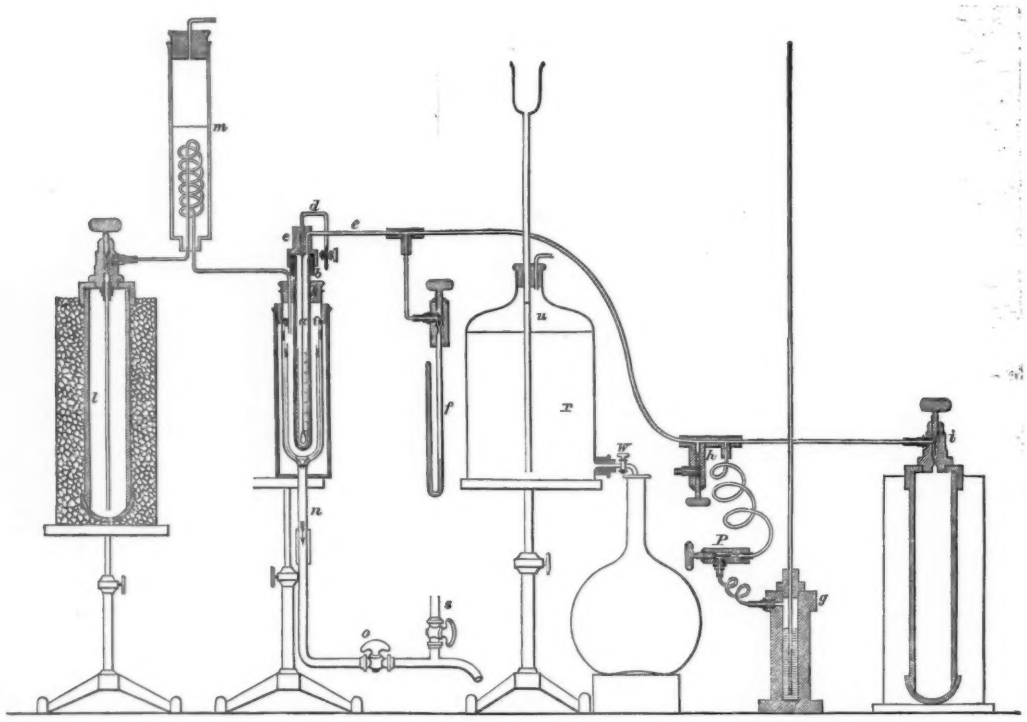
AMONG the numerous subjects which have engrossed the attention of the knowledge-seekers of the present century, probably none have surpassed in fascination and in the wealth of results which have followed persistent effort the question of the possibility of liquefying those gases which for ages had been considered permanent. Immediately after that epoch-making period in chemistry and physics, when Faraday, following in the footsteps of Northmore who in 1806 had succeeded in liquefying chlorine, announced to the world the fruitful results of his experiments upon the liquefaction of gaseous sulphurous, carbonic, and hydrochloric acids, nitrous oxide, cyanogen, and ammonia, came a long interval, during which all attempts to induce hydrogen, oxygen, nitric oxide, marsh gas, and carbon monoxide to take up the liquid state yielded little more than negative results, and the subject appeared almost without hope. When one looks back to the end of the year 1877 and remembers the thrill of excitement which ran through the civilized world when the double announcement was made by the French Academicians that oxygen had been independently liquefied by Cailletet and Pictet, and then, in the mind's eye, reverts to the long years of trial and experiment during which these and other workers were slowly but surely building up future success on present failure, one cannot but be cheered by the thought that patient work inevitably brings its own reward. The fundamental principle upon which both based their experiments was, that the gases must be simultaneously exposed to very high pressures and to temperatures lower than their critical points. Pictet, whose apparatus was a triumph of mechanical skill, evolved his gas to be liquefied from a strong wrought-iron cylinder, from whence it passed into a closed copper tube surrounded by a cold bath of rapidly evaporating liquefied carbon dioxide, which reduced the temperature to $-130°$ C. Cailletet arrived at the same end by using a hydraulic press to compress his gas, but instead of using a very cold bath he caused the gas to effect its own reduction of temperature by suddenly releasing the pressure, causing rapid evaporation, and hence such a considerable cooling that the gas condensed in drops of liquid. Pictet, on January 10, 1878, further succeeded in crowning his results by liquefying hydrogen at a pressure of 650 atmospheres and at a temperature of $-140°$, and finally, on releasing the pressure, by actually solidifying the hydrogen, which fell "like so many drops of steel" upon the ground.

But now came the question of the possibility of producing still lower temperatures, so as to effect the same result at correspondingly lower pressures, and so successful have efforts in this direction been that the more permanent gases have at last been liquefied at pressures nearly approaching atmospheric, and retained in the liquid form under even less than atmospheric pressure. This is a great leap in advance, for it not only enables us to determine the boiling-points of the liquefied gases at ordinary pressure, but also to determine their densities in strictly comparable numbers. This happy consummation we mainly owe to the untiring efforts of Dr. K. Olszewski, whose latest results have just been given to the world, and a short description of whose work will probably be of general interest.

The most critical portion of any apparatus for such a purpose is of necessity the glass tube in which the liquefaction is to occur, the capacity of which for withstanding rapid changes of both temperature and pressure is put to the severest test. Olszewski paid particular attention to the preparation of his tube, heating it for some time almost to redness in an iron tube packed with calcined magnesia, and allowing it to cool slowly beneath a thick layer of hot ashes, thereby obtaining a tube in which more than a hundred experiments were performed without a single explosion. The open end of this tube, *a*, was attached to a brass flange, *b*, the upper part of which was furnished with two openings, one for the hydrogen thermometer, whose bulb reached to the bottom of *a*, the other uniting the tube *a* with a branched copper tube *e*, by means of which connexion could be made at pleasure with (1) the manometer *f*, for use with pressures smaller than atmospheric, (2) an air-manometer, *g*, for use with higher pressures, (3) a large air-pump for reducing the pressure upon the liquefied gas, (4) an aspirator, *r*, used as afterwards described in the density determinations, and (5) an iron Natterer cylinder, *i*, in which the gas to be liquefied was stored up under a pressure of 60–80 atmospheres. A caoutchouc stopper, *k*, held the liquefaction tube within a system of glass cylinders designed for the reception of liquid ethylene, which was used to effect the reduction of temperature, and for preserving the same from the warming influence of the surrounding air. The four vessels were held within each other without touching by pieces of cork and felt rings, so that the ethylene was separated from the surrounding air by badly conducting layers of air, and the evaporated ethylene, passing in the direction of the arrows between the walls, still further counteracted the influence of radiation from warmer surroundings. In the outer cylinder were placed a few pieces of chloride of calcium in order to dry the air and prevent the deposition of hoar frost. The liquid ethylene was supplied from a second Natterer cylinder, *l*, fitted with a siphon arrangement and placed in a mixture of ice and salt; on the way to its receptacle the ethylene passed through a spiral copper tube surrounded by a freezing mixture of solid carbon dioxide and ether contained in a double-walled vessel, *m*. On connecting the vessel with the air-pump and reducing the pressure, the temperature of this freezing mixture sank to $-100°$, and 150 c.c. of liquid ethylene were obtained, which remained perfectly quiet for hours under atmospheric pressure. The glass tube *n* was then connected with the air-pump, by means of which the pressure was reduced until the ethylene began to boil; here however a difficulty, for a long time insurmountable, presented itself; for it was found that inequalities of temperature in the ethylene column caused violent disturbances, and the liquid rapidly disappeared out of the vessel. A simple expedient, however, that of forcing a regulated stream of dry air through the ethylene, was eventually hit upon and

found to work admirably, keeping the whole column in constant agitation and at a measurable temperature. The pressure over the ethylene was maintained by use of the air-pump at about 10 millimetres of mercury.

By this means such a diminution of temperature was effected that all gases, with the exception of hydrogen, could be liquefied at pressures not exceeding 40 atmospheres. As soon as the manometer of the air-pump indicated 10 mm., the valves *f* and *h* were closed, and *i* of the Natterer cylinder opened, admitting the gas to be liquefied into the tube *a* at 40–60 atmospheres pressure, as indicated by the manometer *g*, when a considerable quantity of the liquefied gas was readily obtained. And now Olszewski elaborated a most ingenious device, by means of which the liquid could for some time be retained as such on releasing the pressure, and even—which is almost incredible, and a striking example of the truth of the adage "fact is stranger than fiction"—*in vacuo*. The addition to the apparatus consisted of the introduction in the liquefaction tube of a second thinner-walled tube, about half the length of the former and of smaller diameter, so that, when in position, the distance of its walls from those of *a* was about 1 millimetre. On performing the experiment as before, the liquid first collected only in this interspace, after a short time also in the inner tube, thus exhibiting two meniscuses; eventually the liquid in the interspace flowed over into the inner tube, and finally the levels equalized at its edge. The liquid was now gradually freed from pressure by shutting off the Natterer cylinder and its manometer and opening the valve *h*, and consequently reduced in temperature still further by the evaporation produced, hence the liquefied ethylene became relatively warmer and caused the liquefied gas contained in the interspace to evaporate



entirely away, leaving a badly conducting layer of gas, whose eminent isolating action was found sufficient to keep the remainder in the inner tube in the liquid state at normal atmospheric pressure. One step further: on closing the stopcock *o*, and connecting *h* with *s* by means of lead and caoutchouc tubing, communication was effected between the liquefaction tube and the air-pump, and, owing to the before-mentioned action of the layer of gas, a notable quantity of the liquefied gas still remained at pressures below 100 millimetres of mercury, as shown by the manometer *f*. The temperature of liquefied oxygen under these circumstances sank to −198° C., that of air to −205°, and that of nitrogen to −213°.

In his latest work Olszewski used two such little isolating tubes, and was enabled to reach in case of oxygen −211°; at −207° and 100 millimetres pressure, carbon monoxide solidified, as did also nitrogen at −214 and 60 millimetres.

By lowering the pressure over the solid nitrogen to 4 mm., Olszewski succeeded in penetrating the dark region approaching absolute zero as far as −225° C. It will be remembered that Pictet found a pressure of 650 atmospheres necessary at −140° to liquefy hydrogen, but by combining the above apparatus with one similar to Cailletet's, so that the gas could be subjected to 190 atmospheres pressure at −213°, Olszewski has effected the same result, which was also independently obtained by use of liquefied nitrogen boiling *in vacuo* (*Compt. rend.* xcviii. 913, 1884).

The chief importance of these experiments lies in the fact that it now becomes possible to determine several of the physical constants of liquefied gases at ordinary

pressure, and a short description of how this has been done may not be uninteresting.

In order to determine the boiling-points, about 15 cubic centimetres of the liquid were obtained as above, gently freed from pressure, and communication with the air established by opening the valve *h*. Marsh gas, nitric oxide, and oxygen behaved under these circumstances perfectly quietly, evaporating only from the surface, necessitating shaking of the apparatus to prevent superheating; while in the case of carbon monoxide and nitrogen the evaporation proceeded with gentle ebullition. It required 5 to 15 minutes for the liquid to escape completely out of the apparatus, affording ample time to take the boiling-point with a hydrogen thermometer. A list of the boiling-points obtained is given in the table. It is satisfactory that Wroblewski has completely confirmed the accuracy of Olszewski's temperatures by thermo-electric measurements, and he asserts that a hydrogen thermometer affords correct indications as far as −193°, but the latter gentleman proves that the error must be very small, as all the boiling-points are above −220°, the critical temperature of hydrogen, and he shows that oxygen and nitrogen thermometers are not influenced by an error exceeding 2° even at several degrees below their critical points. From an inspection of the critical points given in the table we can at once see why the earliest attempts to liquefy these gases so utterly failed, for no amount of pressure would liquefy nitrogen for instance, unless its temperature could be at the same time reduced to −146°, a temperature not procurable by the means known to the earlier experimenters.

For the purpose of the density-determinations the inner tube within the liquefaction tube was calibrated, the thermometer removed, and the hole in the stopper closed with glass rod and sealing-wax. About 15 c.c. of the liquefied gas were obtained as before, freed gradually from pressure, and, as soon as all the liquid in the interspace had evaporated, the height of the liquid column left under atmospheric pressure was read off. At the moment of reading off the valve *h* was connected by a caoutchouc tube with the aspirator *r*, and when the gas was completely volatilized, water was run out until the levels in the tube and respirator were again equalized. The volume of water received in the measuring-flask was of course equal to that of the gas formed by evaporation of the known volume of liquid, and, after applying certain corrections dependent upon the nature of the apparatus, was reduced to 0° and 760 mm. As the pressures under which the densities of marsh gas, oxygen, and nitrogen were determined were nearly identical, the numbers obtained are strictly comparable.

	Boiling-point. °C.	Melting-point.	Critical point.	Density.
			°	mm.
Marsh gas	−164			0·415 at −164° and 736
Oxygen	−181·4		−118·8	1·124 at −181·4 and 743
Nitrogen	−194·4	−214	−146	0·885 at −194·4 and 741
Carbon monoxide	−190	−207	−139·5	
Nitric oxide	−153·6		−93·5	

It is a subject for sincere congratulation that these dangerous experiments should have been so far free from accident, but this immunity was not to last *ad infinitum*, for, just as the last experiment with nitrogen was in progress, the liquefaction tube suddenly flew to pieces and so deranged the apparatus that the densities of carbon monoxide and nitric oxide could not be determined.

These researches, taken in conjunction with those of Victor Meyer on the dissociation of the molecule of iodine, and of Lockyer, Liveing and Dewar, and other workers on the effect of high temperature generally in simplifying the structure of molecules, have assisted, and will in the future assist us still more, in arriving at much more accurate views respecting the ultimate structure of matter itself. On the assumption that the molecule of iodine consists of two atoms, which, according to the view now becoming more and more accepted by thinkers on this subject, may themselves consist of aggregations of a still simpler substance—aggregations which, at temperatures obtainable in the laboratory, we have not been able to break up—the classical experiments of Victor Meyer have shown that at a temperature of about 1500° C. the molecules are dissociated into single atoms, that is to say, the intensity of the heat-vibrations is so great that the attraction between the two atoms in the molecule is overcome, and they are torn asunder. At still higher temperatures there is a possibility that the atom itself could be resolved into something simpler still.

Reasoning on the same lines, there is great probability that even hydrogen, oxygen, and other more permanent gases could, by a sufficiently high temperature, be resolved first into single atoms and then into something simpler still. Now, taking the opposite extreme, on reducing the temperature sufficiently to liquefy and even to solidify these gases, we ought to find that as the atoms in the molecule are allowed to approach more closely, and consequently to attract each other more strongly (according to the law of inverse squares), the difficulty of breaking up the molecule into its constituent atoms is more and more increased. This, in the case of liquefied oxygen, has been directly proved to be the case by a series of very beautiful experiments performed by Prof. Dewar, who has shown that liquefied oxygen at −160° C. has not the slightest chemical action upon, among other substances, the alkali metals and phosphorus, which in ordinary air or oxygen are rapidly converted to oxides. Chemical action, if such there had been, would have shown that the force of the attraction of atoms of phosphorus or potassium for those of oxygen exceeded that of the atoms of oxygen for each other; but the result proved that at this low temperature the force (whatever force may mean) exerted between the atoms of the molecule of oxygen was greater than that between the atoms of potassium and oxygen. What the possibilities are as we approach absolute zero form an interesting subject for the "scientific use of the imagination," but, reasoning from analogous phenomena of polymerization, of which organic chemistry furnishes so many examples, and from the antilogous effect of high temperature, we have some reason to suppose that the condensation will continue until molecules more complex than those consisting of the ordinary two atoms are built up. However this may be, the main result of these important experiments has certainly been to show in the clearest possible light how completely the state of matter depends upon the temperature under which it exists.

A. E. TUTTON.

A RECENT JAPANESE EARTHQUAKE.

PROFESSOR SEKIYA, of the Imperial University, Tokio, has lately sent to this country a remarkably interesting and complete record of earthquake motion obtained by him during a severe shock which occurred at 6.52 p.m. on January 15 of this year. The most important portion of the record is shown in Fig. 1, reduced to a little more than one-third of the original size. The motion is recorded (by means of the writer's horizontal pendulum and vertical motion seismographs) in three rectangular components—two horizontal and one vertical—on a plate of smoked glass which is caused to revolve uniformly by clockwork. The plate is started by an electric seismoscope at the beginning of the disturbance, and for one or two seconds its motion is consequently slower than the uniform rate it afterwards attains. On this occasion the plate made one revolution in 126 seconds, and the hori-

zontal motion continued during several revolutions. To avoid confusion only the first of these is reproduced in the figure: the motions which occurred subsequently were smaller, and, as usual, the disturbance subsided very gradually. The circles in which the three components are recorded have been arranged so that simultaneous motions are on the same radius. Radial straight lines, where they are drawn, mark seconds of time. The disturbance begins at *a*, *b*, and *c* in Fig. 1. In its early portion it is marked very conspicuously by a feature which has been noticed (also at the beginning) in previous records—the presence of short-period oscillations superposed on larger and slower motions. These are particularly well defined in the horizontal motion, where they

FIG. 1.—Earthquake recorded at the University, Hongo, Tokio, Japan, January 15, 1887. 6.52 p.m., by Prof. Sekiya. The horizontal motion is magnified 1·8 times; the vertical motion is magnified 2·9 times; the radial lines mark seconds of time.

occur, during the first part of the disturbance, with a period of about one-sixth of a second, or with about twelve times the frequency of the principal motions. The greatest amplitude of horizontal motion is found when these small oscillations have nearly died out, at the place marked A. By that time the vertical motion has become comparatively small. A few seconds later two considerable vertical oscillations appear on the record; but the vertical component is, by a long way, the first to vanish. In the original record the horizontal components are each magnified five times, and the vertical component eight times: the same ratio between horizontal and vertical multiplication is of course maintained in the figure given here. At three places, A, B, and C, the

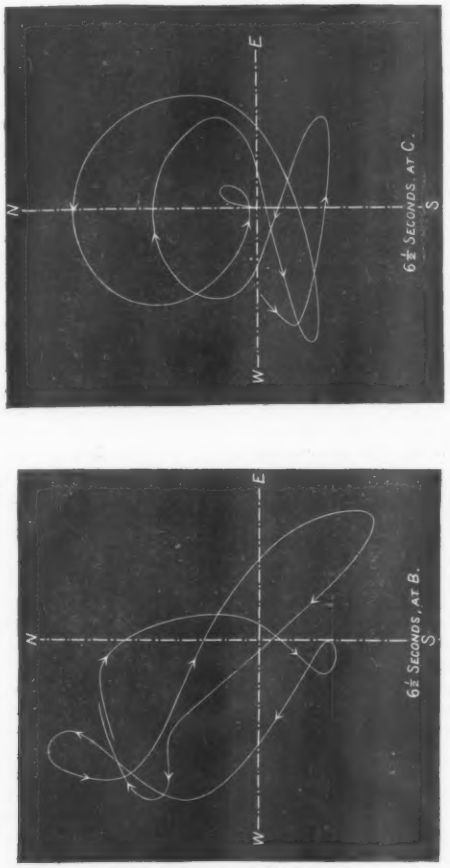


FIG. 2.—Compounded Horizontal Motion.

horizontal motion has been compounded during intervals of 4, 6½, and 6½ seconds respectively: the results are shown to a magnified scale in Fig. 2, and illustrate well the complex character of earthquake motion. The greatest extent of horizontal motion is from one to the other extremity of the figure-of-eight in the first of these diagrams: its actual amount (on the ground) was 7·5 millimetres. The greatest vertical motion was 1·5 millimetres. Other records obtained by Prof. Sekiya lead him to conclude that the greatest vertical motion in Tokio earthquakes is about one-sixth of the greatest horizontal motion. In former examples published by the writer the record was in all cases taken on the soft alluvial soil on which the greater part of the city of Tokio is built. In this instance the record was taken (at the site of the new University buildings, Kaga Yashiki, Hongo) on the much harder ground which here and there rises above the alluvial plain. From a comparison of records taken at the old and the new sites of the Seismological Observatory, Prof. Sekiya concludes that the motion of the alluvial plain is generally greater than that of the higher and stiffer soil in the ratio of two or three to one.

J. A. EWING.

NOTES.

ON Tuesday, Congregation at Oxford declined, by a majority of 106 votes to 60, to sanction the lending of books or manuscripts from the Bodleian Library. This decision is, no doubt, greatly regretted by a number of resident graduates, but it has the cordial approval of most other persons. Had the proposed change been made, it is certain that sooner or later many valuable books and manuscripts would have been lost or injured, and scholars would constantly have found that the works they wanted were "out." It would have been a serious mistake to transform one of the most magnificent collections of books in the world into a lending-library for the benefit of a small class of students.

IN celebration of the fiftieth anniversary of Her Majesty's reign, the general meeting of the Zoological Society of London on June 16 will be held, at 4 p.m., in the Society's Gardens on the lawn, which will be reserved for this occasion. After the usual formal business, the silver medal awarded to the Maharajah of Kuch-Behar will be delivered to His Highness. The President will then give a short address on the progress of the Society during the past fifty years. After the conclusion of the general meeting, the President and Council will hold a reception of the Fellows of the Society and other invited guests.

THE new University of Upsala was opened with great ceremony on May 17. There were present the King and Crown Prince of Sweden, a number of delegates from foreign Universities, the leading Swedish men of science, and some 1500 students. The building is very handsome, and has cost nearly £250,000.

IN the Report of the Royal University of Ireland for 1886, just issued as a Parliamentary Paper, it is stated that last year 2933 persons presented themselves at the various examinations, an increase of 43 on the previous year. The degree of Bachelor of Arts was conferred on 9 women, of whom 4 took honours. One lady was admitted to the degree of Master of Arts, and another, Miss Mary Story, obtained the first place in the first-class honours in modern literature, and won a first-class exhibition. Of the 78 women who presented themselves for matriculation, 71 passed, 27 of them with honours. Speaking of the exhibitions founded by the Drapers' Company and the Irish Society for the promotion of education among women in Londonderry, the Vice-Chancellor says:—"It would be most useful that the example thus set should be followed by others. There are other Companies of the Corporation of London who also hold

property in the district of Londonderry. Surely they could not employ the income, which they hold as a public trust, in a more advantageous manner than in facilitating the education of deserving persons, hindered by straitened means from securing for themselves the benefits of higher education."

AT the last examination of students of medicine at the Nicholas Hospital, in St. Petersburg, fifty-four ladies out of ninety-two obtained their degree.

THE first Danish lady physician, Miss Nielsen, has just begun to practise at Copenhagen. She took her degree with the highest honours.

IN a lucid and interesting article in the *Scotsman*, on "Temperature of the Western Lakes and Lochs," Dr. H. R. Mill sums up the results of various recent observations made by himself and by Mr. John Murray, of the *Challenger* Commission. The eastern fringe of the North Atlantic brings between the western islands water at a uniform temperature of 46°. An equal temperature prevails on the surface, except in the vicinity of land, where it is higher. In nearly land-locked sea lochs and basins the temperature of the mass of water is determined by the configuration, and varies from 47°·5 to 43°·8, according to certain definite laws. In fresh-water lakes, those that are shallow are at a temperature of about 45°; those that are deep are colder, varying from 43° to 41°, and showing hardly any difference in temperature between surface and bottom.

ON May 19, at 22h. 37m. (Greenwich time) a shock of earthquake was felt in the Alpes Vaudoises, at Sion, Bex, Aigle, Vevey, Rougemont, Gessenay, and other places. On May 20, 3 h. 5m., a slighter shock was felt at Rolle (Vaud).

ON May 30, about 3 o'clock in the morning, heavy shocks of earthquake were felt at the city of Mexico. The earth tremor was of a violent kind, and had a lifting motion lasting five seconds. This was followed by a low roar and a strong vibration of the earth from east to west, lasting thirty-nine seconds. The houses rocked, and thousands of people left their beds. It was afterwards found that shocks of earthquake had been general in the States of Hidalgo, Mexico, Morelos, Puebla, Tlascala, Vera Cruz, and Oajaca. The force of the earthquake caused bells to ring and walls to crack. One of the aqueducts bringing water into the city of Mexico was damaged. On the same day a severe shock of earthquake occurred at Benton, Arizona, at noon, and at Nogales, Arizona, at 1 o'clock in the afternoon.

ACCORDING to a telegram from New York, dated May 31, shocks of earthquake have been felt in the islands of St. Lucia, St. Vincent, and Grenada.

A CYCLONE of unusual severity passed over the northern portion of the Bay of Bengal last week. The Calcutta Correspondent of the *Times* says that at the beginning of the week the Meteorological Department reported that a storm had formed near Diamond Island, and was slowly advancing towards the Madras coast. At first the storm appeared likely to strike land near Vizagapatam, but on Wednesday morning it took a more northerly direction, and during the following night passed between Saugor Island and False Point, and thence inland, *viâ* Midnapore and Chota Nagpore. At Saugor Island the wind's rate was sixty-seven miles an hour, when the anemometer and storm signals were blown away. It is believed that the wind attained greater force later.

THE New England Meteorological Society has two special investigations on hand for the coming summer, in addition to its regular work of temperature and rainfall observation. The first special subject (which has been investigated during the last two summers) is thunder-storms in New England; the second is the sea-breeze on the eastern coast of Massachusetts, now undertaken for the first time. The Society would be unable to carry on these inquiries but for the aid received from the U.S. Signal Service, the Bache Fund of the National Academy, and the Harvard College Observatory.

GENERAL GREELY, the new Chief Signal Officer of the United States, has made a laudable effort to publish the Monthly Weather Review as nearly as possible up to time. The Reviews for January and February last have lately been issued—leaving some six months of arrears to be worked up subsequently. If these Reviews are published regularly, and quickly, the current information contained in them will be of much value, as they give not only complete data for the whole of the United States and Canada, but also details of the storms, ice, and fog in the Atlantic Ocean. The Reviews in question are accompanied by a number of very clear charts, one of which shows the tracks of the areas of low pressure over the ocean in each month, and the appendices contain particulars of miscellaneous phenomena and various notes. Among the latter may be specially mentioned articles on sunspots and meteorological phenomena, and results of anemometer observations at sea, with a description of a graphical method for deducing the true velocity of the wind from the records of the instrument and the motion of the vessel.

THE Oficina Meteorológica Argentina has just published vol. v. of its *Anales* (620 pp. 4to, Buenos Aires, 1887), containing the monthly and yearly results of observations made at various stations during the year 1884, together with exhaustive articles on the climate of four places in the Republic, based on observations taken between the years 1855 and 1886. This service, which is undoubtedly the most completely organized of any existing in the South American States, is now under the superintendence of Mr. W. G. Davis, who has succeeded Dr. B. A. Gould, the former Director. A new meteorological observatory is being built at Cordóba, and will be furnished with the best self-recording instruments—the astronomical observatory, with which it has been hitherto connected, being made a separate institution. Several new stations have been recently established in remote places, including an important one on Staten Island (54°-55° south latitude). The service is under the Ministry of Public Instruction.

AT a recent meeting of the Canadian Institute, Dr. Rosebrugh, of Toronto, read a paper on and presented some specimens of the photography of the interior of the living eye. Two series of photographs were shown. The first simply presented views of the optic nerve and retinal blood-vessels. The second series showed not only the retina of the eye, but also an inverted picture of objects to which the eye was directed, depicted upon the retina.

A PHOTOGRAPHER at Pesth has succeeded in taking photographs of projectiles, fired from a Werendler gun, whilst having a velocity of 1300 feet per second. The projectiles appeared on the impressions enveloped in a layer of air hyperbolic in form.

IN a recent communication to the Russian Geographical Society, M. Krasnoff has described the formation, at the present time, of loess from the glacial gravelly clay in the Tian-Shan. The rains which wash this clay take away its finest dust, which is deposited in layers, but accumulates slowly on account of the small amount of rain. M. Krasnoff supposes with much probability that the yellow loess of China originated in this way. As to the flora of the Tian-Shan, M. Krasnoff points out that it formerly held a place between that of the Altai and that of the Alps, and resembled the present vegetation of the Caucasus. The desiccation of the country caused the retreat of the glaciers,

the formation of the debris-covering on the mountain slopes, and the decrease of the lakes. The loess was deposited, and, as desiccation proceeded, the stony and sandy steppes by and by made their appearance. The process of desiccation went on first on the southern slopes of the mountains, where the dry steppe now rises to the limits of perennial snow. With the exception of a few species which accommodated themselves to the new conditions, all plants of an Alpine character and those that grow in moist climates disappeared, as also did the forest vegetation on the dry slopes of the hills. The place of the old flora was taken by immigrants from the drier parts of Asia.

THE death is announced, at the age of seventy-six, of the Swedish botanist, Prof. J. E. Areschong. His best-known works are "Symbola Algarum Floræ Scandinaviæ," "Iconographia Phyctologia," and "Phyceæ Marinæ."

THE Norwegian Storthing has granted £100 to Herr Dahll, to enable him to issue a short popular scientific work on the geology of Northern Norway. The Assembly has, however, refused at present to grant £450 to Prof. W. C. Brögger, who is anxious to complete a work which he has had in hand for several years on the syenite and granite rocks of the mountains around the Christiania fjord.

PERSONS interested in the fisheries of Sweden have often urged that oyster-beds should be formed on the south-west coast of the country, similar to those which have been so successful on the opposite coast of Norway. This is now being done by a Swedish naval captain, Mülenfels, who is founding two oyster-beds on the coast of the province of Bohus. The young oysters to be laid down will be taken from the bed at Öster-Risör, in Norway. The oysters cultivated there are said to equal "natives" in flavour.

ON May 11 the American Oriental Association held its spring meeting in Boston. The number of papers read at the meeting was unusually large. The paper which seems to have attracted most attention was one by Dr. W. Hayes Ward, who offered a new interpretation of a scene presented on a number of Babylonian seals. The late Mr. George Smith thought the design represented the Tower of Babel. Others have held that it is a representation of the underworld opening to receive the dead, and of a porter leading the soul into the presence of a deity. Dr. Ward's theory is that certain prominences invariably found on the seals stand for mountains, as they undoubtedly do in Assyrian art, and that the deity surrounded by rays is the sun-god Shamash. During the night he has been under the earth, and in the morning the porter opens the gate to let him out. In the discussion which followed the reading of the paper, Prof. Lyon, of Harvard College, and Prof. Jastrow, of the University of Pennsylvania, took part; and some evidence was brought forward to show that Dr. Ward's ideas are confirmed by references to sunrise in cuneiform texts.

A FINE series of new colouring-matters has recently been discovered by Dr. J. H. Ziegler (*Berichte der Deut. Chem. Ges.*, No. 8, 1887), by employment of the hydrazine reaction upon amido-derivatives of triphenylmethane. Rosaniline hydrochloride was first converted by nitrous acid into its diazo-derivative, which was then reduced with tin and hydrochloric acid, yielding brilliant green crystals of a hydrazine salt. This new hydrazine, which, in contradistinction to rosaniline, the discoverer terms roshydrazine, is itself a colouring-matter of a somewhat bluer shade than fuchsin, and forms the nucleus of the series. By treatment with aldehyde, acetone, or benzophenone, condensation products are obtained possessing brilliant colours, varying from red to violet; benzaldehyde and aceto-acetic ether, on the other hand, yield beautiful blues, while grape-sugar forms with roshydrazine a dye of a greenish-blue tint. Very numerous shades are further produced by action of many other reagents, and, moreover, the sulpho-derivative of roshydrazine appears to form a second series of coloured substances quite as numerous as those of the nucleus itself. Indeed, the discovery will, in all likelihood, prove a very rich one, and will afford another instance of the immense assistance which pure chemistry so frequently furnishes to the commercial world. The fact of most vital importance about these new colours, which are practically insoluble in water, is that they may be readily prepared *in situ* upon the fibre, it being only necessary to immerse it first in a bath of roshydrazine, and afterwards in a second bath containing the condensing reagent.

MESSRS. LONGMANS are preparing for publication "Modern Theories of Chemistry," by Prof. Lothar Meyer, translated from the fifth edition of the German by Prof. P. Bedson and Prof. W. C. Williams; "Electricity for Public Schools and Colleges," by W. Larden; "A Text-book of Elementary Biology," by Prof. R. I. H. Gibson; "The Testing of Materials of Construction," by W. C. Unwin, F.R.S.; and "Astronomical Work for Amateurs: a Practical Manual of Telescopic Research adapted to Moderate Instruments," edited by I. A. W. Oliver, with the assistance of Messrs. Maunder, Grubb, Gore, Denning, and others.

MANY of the beautiful Alpine flowers, especially the edelweiss and the Alpine rose, are in danger of becoming extinct. The Government of Valais and the Monte Rosa section of the Alpine Club, have caused gardens to be laid out and inclosures to be made for the cultivation and protection of these plants. The station on the Tête de Mouton, near Vissoye, in the Einficht Valley (Valais), situated at the height of 2300 metres, cultivates not only plants belonging to the Alps, but some from the Pyrenees, the Himalayas, and the Caucasus.

IN the Report of the Rugby School Natural History Society for 1886, just issued, the editors are able to congratulate the Society on the number of its members and associates being greater than in any previous year. Among the contributions printed with the Report are papers on the motion of stars in line of sight, the dispersion of seeds and spores, Danes' Blood, and the protective colouring and form of animals.

THE Grand Duke Nicholas of Russia, eldest son of the Grand Duke Michael Nicholaievitch, has, it is said, written a book on the entomology of the Caucasus. His Highness is an ardent student of natural history, and studies every new work on the subject published in England, France, and Germany.

AT a recent meeting of the Natural History Society of Wisconsin, Dr. Peckham, the President, read an interesting paper on wasps, presenting the results of many experiments made in 1886 on the mental habits and peculiarities of these insects. In the section entitled "Emotions," Dr. Peckham discusses the question whether wasps have much sympathy with the suffering of their fellows. "To be sure," he says, "when we caught numbers of them, and painted them within the cage, they at once went to work to clean each other, and this seems to show that they have some desire to aid and comfort their friends. But we have often seen them continue to eat, with entire composure, near the body of one of their number that had just been crushed to death; and they frequently fall upon a dead relative, cut it up, and carry it into the nest to feed their young. An overpowering sense of utility is probably the cause of this cannibal propensity; as was the case in Tierra del Fuego where the natives were frequently forced, through stress of weather and scanty food-supply, to eat their old women."

In the number dated April 19, *Science* publishes an excellent ethnographic map, by Mr. A. S. Gatschet, representing the linguistic families of the Indian dialects in the south-eastern parts of the United States, so far as they can be traced by the study of actual remnants of tribes still lingering in or near their old haunts, and by historic research. Of all the families represented on the map, the Maskóki were at one time most important. It is said that in former times the tribes of this family extended from the Atlantic to the country beyond the Mississippi, and from the Appalachian Range to the Gulf of Mexico. The majority of the Maskóki tribes now live in the eastern parts of the Indian Territory.

Prof. G. Pouchet has recently published a long and interesting paper concerning the life and work of Ch. Robin, the late Professor of Histology in the Paris Medical School. A complete list of Robin's works adds greatly to the value of the paper.

The fourth number of the *Annales de l'Institut Pasteur* contains many interesting papers, among which are one by Duclaux, on the general biological phenomena of micro-organisms, and one by Bardach, Perroncito, and Carita, on the presence of the Bacillus of rabies in milk.

An explosion of natural gas, which had leaked from pipes and mixed with the atmosphere, took place lately at Youngstown, Ohio. The result was a fire, which burned down a church and a large number of new buildings. The cause of ignition was the lantern of a watchman, who narrowly escaped death. The use of natural gas as an illuminant and fuel is attended by considerable danger, because, being inodorous, it may leak without anyone noticing the fact until a disaster occurs.

In a pamphlet issued lately by the U.S. Hydrographic Office, Lieut. Underwood says that mineral oils are not so effective for use at sea as vegetable or animal. A comparatively small amount of the right kind of oil, say two quarts per hour, properly used, is sufficient, he asserts, to prevent much damage, both to vessels and to small boats, in heavy seas. The greatest result from oil is obtained in deep water. In a surf, or where water is breaking on a bar, the effect is not so certain; but, even in this case, oil may be of benefit, and its use is recommended by Lieut. Underwood. He advises that, when an attempt is about to be made to board a wreck, the approaching vessel should use the oil after running as close as possible under the lee of the wreck. The wreck will soon drift into the oil, and then a boat may be sent alongside of her.

According to an official notification of the Trustees of the Schwestern Fröhlich Stiftung, at Vienna, certain donations and pensions will be granted from the funds of this charity this year, in accordance with the will of the testatrix, Miss Anna Fröhlich, to deserving persons of talent who have distinguished themselves in any of the branches of science, art, or literature, and who may be in want of pecuniary support either through accident, illness, or infirmity consequent upon old age. The grant of such aid is primarily intended for Austrian subjects; but foreigners of every nationality, if resident in Austria, may benefit by the Trust. Austrian subjects residing in England may also make application for a grant. Applications addressed to the Trustees (das Curatorium) must be transmitted to the President's office of the Common Council of the City of Vienna (an das Präsidial-Bureau des Wiener Gemeinderathes Neues Rathhaus) before August 31, 1887, through the Austro-Hungarian Embassy in London, 18 Belgrave Square, S.W., where particulars as to terms and conditions may be obtained.

The Gold and Silver Commissioners have requested Mr. Henry Dunning Macleod to investigate the relation between money and prices.

In Mr. Abercromby's article last week on equatorial wind currents and Krakatão dust, the end of the last paragraph but two (p. 87) should read thus—"and though the highest currents over the Polar limit of both the south-east and north-east trades are from north-west and south-west [not south-east] respectively," &c.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mrs. C. J. Fisher; a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mrs. Yeates; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. T. H. Kenyon, R.N.; a Brown Bear (*Ursus arctos*) from Northern Europe, presented by Mr. John Rhind; a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss Muriel Reed; a Blyth's Tragopan (*Ceriornis blythi*) from Upper Assam, presented by Mr. W. Brydon; a King Vulture (*Gypagus papa*) from Tropical America, presented by Mr. W. Allen Sumner; two Little Guans (*Ortalis motmot*) from Guiana, presented by Mr. W. Thomson; six European Tree Frogs (*Hyla arborea*), European, presented by Mr. E. Wroughton; a Larger Hill Mynah (*Gracula intermedia*) from Northern India, four Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, deposited; a Patagonian Conure (*Conurus patagonus*) from La Plata, two Dark-green Snakes (*Zamenis atrovirens*) from Dalmatia, four Axolotls (*Siredon mexicanus*) from Mexico, purchased; a Common Rhea (*Rhea americana*) from South America, received in exchange; a Molucca Deer (*Cervus moluccensis*); a Japanese Deer (*Cervus sika*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Paris Observatory.—We have received Admiral Mouchez's Report for the year 1886, which was presented to the Council of the Observatory on February 4, 1887. Admiral Mouchez first refers to M. Lœwy's proposed new methods for determination of the constant of refraction and of the constant of aberration, the principles of which have already been explained in this column. With regard to refraction, it is pointed out that the exact determination of its amount at different altitudes and under varying conditions is of peculiar interest for an Observatory situated as that of Paris is, on the southern borders of a large city, so that the temperature of the strata of air to the north and to the south will probably differ considerably. M. Mouchez hopes that during the current year it will be possible to attack these fundamental problems with an instrument constructed on M. Lœwy's plan. The great meridian instrument and the Gambey circle have been actively employed during the year, a grand total of 16,505 observations having been obtained, 798 of which refer to planets, including 148 of the sun and 128 of the moon. The principal meridian work continues, as in recent years, to be the re-observation of Lalande's stars. The equatorials have been employed in the observations of comets, minor planets, nebulæ, eclipses of Jupiter's satellites, and occultations. It is almost unnecessary to remind our readers of the magnificent work in astronomical photography which has been carried on by the MM. Henry, and which embraces planets and their satellites (Hyperion has been photographed with an exposure of thirty-five minutes), the moon and stars, including clusters and double-stars. M. Mouchez reports that he is considering how the stellar photographs may be most conveniently utilized for the formation of a catalogue, and states that, before final decision, he awaits the results of the then approaching meeting of the Astronomical Congress. The macro-micrometer devised by MM. Henry for measuring the relative positions of stars on the photographic plates is described in detail, and some results of double-star measurements made with this instrument are appended. It appears that these are of considerable accuracy, the mean error of a single measure for the double-star ζ Ursæ Majoris being 0″·077 in distance and 0°·55 in position-angle.

ASTRONOMICAL PHOTOGRAPHY.—The *New Princeton Review* for May 1887 contains an interesting article, by Prof. C. A. Young, with the above title. The article is, of course, of quite a popular character, but none the less is it deserving of perusal by astronomers—professional as well as amateur. In a rapid survey of the history of astronomical photography, Prof. Young refers briefly to the labours of J. W. Draper, Bond, Rutherfurd, Gould, Henry Draper, and Pickering, in America; of De la Rue, Common, and Roberts, in England; of the Brothers Henry, in France; of Vogel, in Germany; and of Gill, in South Africa. He then goes on to discuss the relative advantages and disavantages attending the employment of the reflector and of the refractor respectively in this particular department of astronomical science; pointing out, in the case of the refractor, the two directions in which, at the present time, efforts are being made to overcome the difficulties arising from the want of perfect achromatism of the object-glass, viz. Prof. Abbe's researches on the production of glass which shall be perfectly achromatic, and Herr Vogel's investigations on a new sensitizing medium which may be as sensitive to the yellow and green rays as the salts of silver are to the violet rays. In the remaining portion of the article Prof. Young distinguishes two classes of astronomical photographs: those in which the end is to produce a *picture* of the object; and those which are made for purposes of *measurement*, and the determination of precise numerical data. He gives various examples of each class, with a brief account of the progress which has been made in solar, lunar, planetary, stellar, and nebular photography, as thus classified, concluding with an account of the very remarkable results which have recently been obtained by Prof. Pickering in the photography of stellar spectra.

COMET 1887 *e* (BARNARD, MAY 12).—Dr. H. Oppenheim (*Astron. Nachr.* No. 278) has computed the following elements and ephemeris of this comet from an observation made at Cambridge, U.S., on May 12, and from two others made at Rome on the 15th and 17th :—

T = 1887 June 24·5559 Berlin M.T.

$\pi - \Omega = 24^\circ\ 21'\ 30''$
$\Omega = 244\ 54\ 32$ } Mean Eq. 1887·0.
$i = 17\ 9\ 21$
$\log q = 0{\cdot}11510$

Ephemeris for Berlin Midnight.

1887.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log r.	Brightness.
June 1	15 49 55	16 12·3 S.	9·5323	0·1299	2·0
5	16 0 2	12 19·1	9·5185	0·1253	2·2
9	16 10 46	8 17·1	9·5097	0·1216	2·3
13	16 22 1	4 13·9	9·5062	0·1186	2·4

The brightness on May 12 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JUNE 5–11.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 5.

Sun rises, 3h. 48m.; souths, 11h. 58m. 10·2s.; sets, 20h. 8m.; decl. on meridian, 22° 33′ N.: Sidereal Time at Sunset, 13h. 4m.

Moon (Full on June 5) rises, 19h. 31m.; souths, oh. 4m.*; sets, 4h. 32m.*; decl. on meridian, 18° 7′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	4 15	12 44	21 13	25 6 N.
Venus ...	6 47	15 1	23 15	23 8 N.
Mars ...	3 14	11 15	19 16	21 13 N.
Jupiter...	15 26	20 44	2 2*	8 56 S.
Saturn...	6 29	14 35	22 41	21 56 N.

* Indicates that the southing and setting are those of the following morning.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei ...	0 52·3	81 16 N.	June	8, 1 16	*m*
β Libræ ...	14 54·9	8 4 S.	,,	11, 1 52	*m*
U Coronæ ...	15 13·6	32 4 N.	,,	7, 23 48	*m*
W Scorpii ...	16 5·2	19 51 S.	,,	7,	*M*
U Ophiuchi...	17 10·8	1 20 N.	,,	10, 0 14	*m*

M signifies maximum; *m* minimum.

Occultations of Stars by the Moon (visible at Greenwich).

June.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
5 ...	29 Ophiuchi ...	6	20 52 ...	21 59 ...	60 224
6 ...	B.A.C. 6081 ...	6	20 40 ...	21 39 ...	20 258
10 ...	45 Capricorni ...	6	23 49 ...	0 53† ...	42 275
10 ...	44 Capricorni ...	6	23 58	near approach	156 —

† Occurs on the following morning.

Saturn, June 5.—Outer major axis of outer ring = 38″·1; outer minor axis of outer ring = 15″·2; southern surface visible.

Meteor-Showers.

	R.A. °	Decl. °	
Near Antares	249	20 S.	
β Ophiuchi	261	5 N.	Rather slow.

GEOGRAPHICAL NOTES.

THE Expedition which went out to explore the New Siberian Islands, has returned to St. Petersburg with interesting results. The Expedition was organized by the Academy of Science, St. Petersburg, 26,000 roubles being contributed by the Emperor Alexander. Operations commenced in 1885, and considerable preparations had to be made. A winter retreat was chosen in the district of Kasachje (under 71° N. lat.), 30 kilometres south of Ustjansk at the mouth of the Jana. About 270 kilometres distant from Kasachje, were discovered the remains of a mammoth. At the end of March 1886, Dr. Bunge left for the Swatoinoss Mountains, where the real march with 240 dogs was to begin; 19 sledges drawn by 12 dogs, led the expedition over the frozen sea. In the latter half of April, the Jakutes returned with the sledges, and reported that the journey had been successfully accomplished. Dr. Bunge devoted his attention in particular to the Liachow Island, while Baron Toll attempted not only Kotelni Island, but also the Island of New Siberia. In May both explorers were at the Medwesh.i foothills, to the south of Kotelni Island. Liachow Island has a very uniform but rough appearance; it is 300 kilometres in circumference, the surface being uneven and hilly. The prevailing winds are east and west. The latter is extraordinarily violent, and works great mischief; it brings first rain, and then frost. Winter retires about the beginning of June, although the summer is never quite free from snow, mist, storms, &c. Enormous masses of perpetual ice inclose the island; only once could Dr. Bunge make a sea passage free from ice. In clear weather, looking northwards from Kotelni Island land is visible, which appears to be only 150 kilometres distant. The possibility of reaching this land is increased by the fact that a warm current flowing in a fixed direction prevents the sea from freezing over. The highest observed temperature in Liachow Island was only 8° (Réaumur). The snow melted in the beginning of June, and about the middle of the same month the first flower was found. Wild reindeer, wolves, Arctic foxes, and mice are found on these islands, as also sea-gulls, snipe, and other birds. With the exception of the mouse, all animals on the island are merely guests; they all winter on the land.

THE Canadian Government sent out at the beginning of May an Expedition for the exploration of the region watered by the great river Yukon in the north-west of the Dominion. The geology and natural history of the Expedition will be under the care of Dr. Dawson of the Canadian Survey; while a careful topographical survey will be made by Mr. W. Ogilvy.

IN the new number (128) of the *Zeitschrift* of the Berlin Geographical Society, Prof. Blumentritt has some critical remarks on the Spanish data with reference to the distribution of the native languages in the Philippines. Colonel Schelling contributes a useful abstract of the Russian Survey work up to 1885, and Dr. Emil Deckert a paper on the country and people of the Southern United States.

THE German Government has appointed Lieut. Kund, who has done such good work in the Congo region, chief of the scientific station which has been established at the Cameroons; for when the Germans undertake the development of any region they at once recognize the nece sity for scientific observations in order to accomplish their object. A surgeon and botanist will

also be appointed, and the party will remain three years at the Cameroons. The surgeon and botanist will have charge of the meteorological station, while Lieut. Kund will devote himself to the exploration of the interior lying to the east of Cameroons.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held on Thursday, Friday, and Saturday of last week, in the Theatre of the Institution of Civil Engineers, under the presidency of Mr. Daniel Adamson.

In his inaugural address the President exhaustively treated the question of the selection and adoption of metals for various purposes in the arts. Commencing with the purest iron obtainable, containing only 0·08 per cent. of foreign matter, he explained that it was wonderfully malleable, and welded at a comparatively low temperature; a further exceptional characteristic of such a metal was that it suffered little when worked at a colour-heat, whilst it endured percussive or concussive force without distress much better than the mildest steel. All the alloys of iron, or the steels, were less malleable and ductile than the pure metal, but were on the other hand much stronger, or possessed a much higher carrying power. Pure iron would maintain a maximum load of nineteen tons per square inch, whilst it would set at half that amount. By an addition of 0·13 per cent. of carbon, 0·52 per cent. of manganese, and 0·10 of silicon, sulphur, and phosphorus, a steel might be produced carrying 50 per cent. more than pure iron, whilst by a further addition of these elements, the carrying power might be increased to sixty tons per square inch. In thus increasing the strength, the ductility or reliability was reduced however in nearly the same proportion. It thus becomes evident how important is the selection of material for a given purpose, but besides this the stronger the material the more skill is required in working it, and the more forethought has to be manifested by the constructive engineer.

Referring specially to the subject of steel for guns, the President drew attention to the diversity of opinion, both in England and the United States of America, as regarded the selection of the proper metal and its treatment for ordnance, the artillerists maintaining that a strong and consequently hard steel was desirable, whilst engineers contended that a mild tough metal should be used; this was a question which he thought might be decided by the Iron and Steel Institute, with the result that guns would be made, as they could be made, which would not burst. He referred to what had been done by the late Sir Joseph Whitworth towards the compression and consolidation of steel, and by the late Sir William Siemens, especially as regarded the production and introduction of soft or ductile steel, which possessed great regularity in quality by the uniformity of its composition.

Another most important subject treated of was that of steel rails and weldless solid rolled steel tires. By this application of steel, the saving to railway companies had been estimated at 1 per cent. on the dividend, and this was largely due to the efforts of Sir Henry Bessemer; and he thought it was quite within the province of the Institute to suggest the most suitable material for the construction of railway and river bridges of moderate and large spans, by the application of which further economy would be effected.

After reference to the subjects of case-hardening weldable steel—for which, when manufactured with reliability and economy, there would be an enormous demand—cast-iron, and steel castings, the address concluded by drawing attention to the influence of high railway rates upon trade depression, and to the necessity of employers and employed working in unison, as by their intelligent action alone could we expect to defy the contention and competition of the world. The vote of thanks for the address was proposed by Sir Lowthian Bell, and seconded by Sir James Kitson.

A paper on the Terni Steel Works was read by Sir Bernhard Samuelson, which he prefaced with some remarks on the importance of testing commercial education, which was now under the consideration of the Oxford and Cambridge Joint Board for Local Examinations, and drew attention to the circumstance that Chinese and Japanese were being taught on the Continent in anticipation of trade being opened out with the East.

The next paper was by Mr. George Allan, on "Patent Composite Steel and Iron." After referring to the necessity for a material of this character, and the various attempts that had been made to produce it, the author proceeded to explain the method of its manufacture. This consisted in embedding fibrous iron in mild steel, and subsequently rolling the ingots into bars or plates as desired. "So perfect was the union of the two materials, that by an inspection of the samples when the covering of steel was turned down to the strands of iron and the surface polished it was quite impossible to detect any separation between the two materials, or which was iron and which steel."

The next paper read was by Prof. Chandler Roberts-Austen, descriptive of a mode of electro-deposition of iron, and illustrated by a medallion in iron of Her Majesty executed by the process, the secret of success in which appears to be the employment of very feeble currents. The adherence of the deposited iron to the surface of the copper gives rise to considerable difficulty in detaching it; this was obviated by depositing nickel in the first place, allowing it to oxidize slightly, then again depositing nickel and the iron on its surface. The subject was still under the author's investigation.

The first paper read on Friday was one by Sir Bernhard Samuelson on the "Construction and Cost of Blast Furnaces in the Cleveland District," supplementary of one read in 1870, before the Institution of Civil Engineers.

Mr. James Riley, to whom the Bessemer Medal for this year has been awarded for his excellent work in developing the manufacture and high quality of mild steel, read a paper of a most elaborate character on "Some Investigations as to the Effects of Different Methods of Treatment of Mild Steel in the Manufacture of Plates." The author compared reheating with soaking, or cooling gradually in pits; hammering with cogging; cross-rolling with rolling in one direction only, and the results due to different amounts of work.

It was found that the soaked ingots were slightly more satisfactory than those reheated, the reheating having been performed in a non-radiation furnace, and that the results of cogged and hammered ingots were almost similar. Cross-rolling and ordinary rolling were also found to give almost similar results. As regards "working" the ingot, the strength of the steel was found to increase with the quantity of work put upon it, the ductility being however diminished. The author looks upon annealing as a corrective to damage done, and thinks that as regards the ordinary operations of a well-managed works annealing is unnecessary. The paper relates to a very large number of experiments, the bending tests alone being close upon 1300, and gave rise to a very animated discussion.

Other papers on the programme, including one by Dr. H. C. Sorby, F.R.S., on "The Microscopical Structure of Iron and Steel" were taken as read. With reference to this paper, Dr. Percy, the immediate Past-President, remarked before resigning the chair, "For twenty years, more or less, he has been engaged in this kind of research, in which of late much has been done by foreign observers. Having carefully studied whas has been published on this subject, my conviction is that, with regard to originality of contrivance, accuracy, and importance, the work of Dr. Sorby is as yet unrivalled. He has successfully explored a comparatively new and most important field of inquiry, and has thrown much light on some of the most recondite problems concerning the mechanical and physical properties of iron and steel. My first impression is that the result of such researches will prove to be of the highest practical value."

THE INSTITUTION OF MECHANICAL ENGINEERS.

AT the recent meeting of the Institution of Mechanical Engineers, the President, Mr. E. H. Carbutt, gave an address, in which he reviewed the progress made in the manufacture of guns during the last half century. The guns in use at the beginning of the present reign, in 1837, were principally the cast-iron smooth-bore 24-pounder and 32-pounder with spherical shot. Now they are made of steel, and provided with mechanical appliances for every movement; accuracy of aim is insured by rifling, and the length of range increased by the use of an elongated shot of small cross-section, and by increased powder-charges. Breechloading has led to increased speed of firing, and to the use of guns 35 and 40 feet long on board ship. The loading is self-acting in the smaller field guns, whilst on board ship the guns are made to revolve, load, return to position, and train to firing-point by hydraulic power. Such guns

weigh 110 tons, fire shot 16¼ inches in diameter, weighing 1800 lbs., and costing £190 each. The advance thus shortly chronicled is due to several workers, prominent amongst whom may be mentioned Sir Joseph Whitworth, Sir William Armstrong, and Sir William Anderson. The production of ordnance of such a character has been due to the introduction of steel, and the possibility of producing steel in large masses by means of the open-hearth steel process, with which the name of Sir William Siemens will always be connected. The quick-firing machine guns are known by the names of their inventors, as the Gardner, Nordenfelt, Maxim, Gatling, and Hotchkiss.

The President also drew attention to the circumstance of the inventive talent of the country having been taken advantage of here, and ignored in France until after the Franco-German war; now, however, there as here, many works have found it to their profit to establish gun factories which supplement the Government factories to a large extent.

Two papers were read at the meeting on prime movers, the one by Mr. F. Brown, of Montreal, on "The Construction of Canadian Locomotives," and the other, by Major T. English, R.E., detailing experiments on the distribution of heat in a stationary steam-engine. The former, as its name denotes, refers to details of construction; the latter is illustrated by thirty-five figures, mainly of indicator diagrams, and distribution of heat diagrams showing in one view the applied and wasted heat. The series of trials extended altogether over fifty hours' working of the engine; but out of this trial, various results, representing in the aggregate twenty-eight hours' working, were rejected, on account of doubtful measurements at some point or other. The remaining trials are sixteen in number, in two sets—one condensing and one non-condensing—each with and without the steam-pipe jacketed, and each with a cut-off at approximately one-quarter, one-eighth, and one-sixteenth of the stroke respectively, thus making twelve different combinations. The conclusions drawn by the author are: that, in order to obtain the best results for any given range of temperature, there should be a definite relation between the surface of the steam passages, the diameter of the cylinder, and the length of stroke; and that in the design of a steam-engine the adjustment of these proportions is perhaps the most important point to be considered as regards economy. The calculated results of varying the length of the stroke of the engine which was experimented on—while the diameter of the cylinder, the absolute clearance volume, and the clearance surface exposed, remained unaltered—were tabulated for two different points of cut-off, and show that the same number of expansions may give widely different results as regards the ratio of efficiency and the water consumed per indicated horse-power per hour; and also that with the same length of stroke these results are but slightly affected by doubling the number of expansions.

NOTE ON THE SPECTRUM OF DIDYMIUM.[1]

IT is well known that the absorption spectrum usually ascribed to didymium shows six bands in the blue and violet with approximate wave-lengths 482, 476, 469, 462, 444, 428, according to Lecoq de Boisbaudran.

The evidence that we at present possess shows, I think, that these bands belong to at least five different fractions of didymium.

Welsbach (*Monatshefte*, vi. 477) has shown that the band 428 occurs in the absence of all the others mentioned above in the spectrum of the fraction which he names neodymium. On the other hand, Crookes (Proc. Roy. Soc., 1886, 502, Fig. 1) has shown that all the other bands of neodymium can be obtained in the absence of the band 428. This band, therefore, belongs to a distinct fraction, and should be obtainable quite by itself.

Crookes has shown that the band 444 varies in strength independently of all others, and is therefore distinct. The same conclusion is arrived at by a slightly different argument. Welsbach's praseodymium shows the bands 482, 469, and 444, together with a faint band in the orange. Crookes (*ibid.*, Fig. 1) has shown that 482 and 469 can be got in a fraction which does not show 444. It is possible that the faint orange band of praseodymium belongs to the same fraction as 444, since its presence or absence would make little difference in the appearance of the dark orange band of the ordinary didymium spectrum, one part of which it forms.

The band 462 is shown to be distinct by a comparison of Crookes's Figs. 1 and 2, taking into account that 444 and 428 have been shown to be distinct.

The two bands 482 and 469 seem always to accompany each other. They occur together in Welsbach's praseodymium and in all the spectra of didymium fractions published by Crookes. They are distinct from 476, since they occur in praseodymium in the total absence of 476. They may belong to the same fraction as the faint orange band of praseodymium.

The band 476 does not occur in Welsbach's neodymium spectrum.

In fact the two bands 476 and 462 seen in the didymium spectrum are not accounted for by Welsbach at all in the spectra of praseo- and neodymium. Since 462 is distinct, 476 must also be distinct.

I have repeated Welsbach's experiments up to a certain point, and can confirm his results as regards praseodymium in every respect. There is no indication whatever that the three main bands belong to different fractions. I have not been able to satisfy myself quite that the faint orange band of praseodymium really belongs to the same fraction as the others, even supposing that the method of fractionation is not changed. In the didymium spectrum the orange band is much darker than the green, and the difficulty of getting a really concentrated praseodymium solution, which does not show a trace of the green band, is extreme. A small remnant of some other fraction of didymium might therefore cause a faint band in the orange some time after the band in the green had disappeared. Nevertheless, there is no doubt that by Welsbach's method the orange didymium band is split up, for the maximum absorption with didymium is not at the point in the orange where the band of praseodymium occurs.

I have not yet obtained the neodymium fraction free from praseodymium, but I have no reason to doubt that Welsbach's observations are correct. A study of the intermediate fractions brings out a point which Welsbach does not refer to. As we pass from the praseodymium end the bands 482 and 469 become fainter, whilst 476 and 462 first appear and then grow stronger, till they become distinctly stronger and much broader than 482 and 469.

It appears then that the absorption spectrum of didymium is splitting up just as the fluorescent spectrum of yttrium is. I have only discussed a few of the bands, but there is no doubt that the other bands will also in time be separated. Indeed, this separation has already been partially effected by Crookes for some of the bands in the red.

Perhaps the most surprising result arrived at by Crookes is that the splitting up of the fluorescent yttrium spectrum is unaccompanied by any change in the spark spectrum. On the other hand, Welsbach states that the spark spectra of praseo- and neodymium are parts of the didymium spectrum, and that, though similar in general appearance, they are really quite distinct. There does not appear to be any theoretical reason for this difference between yttrium and didymium, and it is to be hoped that the different fractions of didymium will be got pure enough to show whether the spark spectra can be still further split up.

CLAUDE M. THOMPSON.

University College, Cardiff.

[1] Reprinted from the *Chemical News*, May 20, 1887.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The first election to the Harkness Scholarship for Geology and Palæontology will be made in June. All B.A.'s of Cambridge not beyond M.A. standing are eligible. The Rev. Osmond Fisher is appointed an elector to the scholarship.

The report of the Council of the Senate on the teaching of geography is to be voted upon on June 9.

SCIENTIFIC SERIALS.

American Journal of Science, May.—On red and purple chloride, bromide, and iodide of silver; on heliochromy and the latent photographic image, by M. Carey Lee. To this paper we have already called attention. It is the first of a series of important papers, the object of which is to show (1) that chlorine, bromine, and iodine may form compounds with

silver of beautiful peach-blossom, rose, purple, and black coloration; (2) that these compounds (except under the influence of light) possess great stability, and may be obtained by purely chemical means in the entire absence of light; (3) that the red chloride shows a tendency to the reproduction of colours, and may probably be the material of the thin films obtained by Becquerel and others in their experiments on heliochromy; (4) that these substances constitute the actual material of the latent or invisible photographic image, a material that may now be obtained in any desired quantity without the aid of light. They also form part of the visible product resulting from the action of light on the silver haloids. This first contribution deals with red silver chloride, and with the relations of photochloride to heliochromy. The author considers that in the reactions here described lies the future of heliochromy, and that this beautiful red chloride may ultimately lead to the reproduction of natural colours.—On the inter-relation of contemporaneous fossil floras and faunas, by Charles A. White. A chief object of this paper is to show that successive orders of fossil floras and faunas do not necessarily correspond so absolutely with given geological epochs as is generally assumed. On the contrary, the rate of progress of biological evolution from epoch to epoch has necessarily been variable, some contemporary species dying out at an early date, while others live on into subsequent epochs, according to the different conditions of their environments. Living species of land mollusks, for instance, are found also associated in the same strata with those of extinct genera and families of Miocene vertebrates. It is also incidentally shown that no European palæontological and geological classifications are entirely applicable to the conditions prevailing in the American continent.—The Eozoonal rock of Manhattan Island, by L. P. Gratacap. An examination of the rock recently exposed in New York when the cisterns were being constructed for the Equitable Gaslight Company, leaves little room to doubt that here a bed of hornblende has undergone a more or less complete conversion into serpentine, the change being in some places accelerated by the elimination of lime carbonate as calcite, and probably elsewhere the double carbonate of lime and magnesia as dolomite.—Terminal moraines in Maine, by George H. Stone. The generally unequal distribution of the glacial drift in Maine is well illustrated by the detailed description here given of its chief terminal moraines.—Note on the enlargement of hornblendes and augites in fragmental and eruptive rocks, by C. R. Van Hise. While recently studying the eruptive rocks of the Penokee-Gogebic iron-bearing series in Michigan and Wisconsin, the author met with cases of new growths occurring upon augite and hornblende, corroborating the observations made by Fr. Becke amongst the eruptive rocks of Lower Austria in 1883. In some instances the augite has been completely, in others partly, changed into hornblende, the rocks where these new growths occur being altered diabases.—The great Acadian Paradoxides, by G. F. Matthew. An almost complete specimen of this gigantic species has recently been found in the Cambrian basin of St. John, differing from any hitherto described, and mostly resembling the *P. bennettii* of Newfoundland and *P. harlani* of Massachusetts.—On the kin of *Paradoxides* (*Olenellus?*) *kjerulfi*, by G. F. Matthew. The object of this paper is to throw some light on the comparative age of the Paradoxides beds in Europe and America, and the probable position of Olenellus in relation thereto, the allies of *P. kjerulfi*, Linrs., being chiefly considered.—On Taconic beds and stratigraphy (continued), by James D. Dana. This second communication, which is accompanied by a large map of the Taconic region in Berkshire, Massachusetts, deals specially with the middle and northern part of that region. The author concludes generally that the limestone must be the underlying rock for the lower and narrower portions of the Taconic range, the schists of which are the same in kind, and essentially continuous. Most of the limestones are referred to the Lower Silurian age, some Cambrian also occurring.

Rendiconti del R. Istituto Lombardo, March 31.—On some methods of testing the purity of drinking-waters, by Prof. L. Maggi. Koch's method by cultivation in gelatine is shown to be greatly inferior in efficacy to that of Fol and Dunant by cultivation in meat extract, the former detecting only 5700 bacterial germs where the latter finds 100,000. The author points out further that Fol and Dunant's is substantially the same as the method already adopted at a much earlier date (1867) by himself and Prof. Giovanni Cantoni.—Meteorological observations made at the Brera Observatory, Milan, for the month of March.

April 14.—Effects of a thunderbolt, by Prof. R. Ferrini. During a recent thunderstorm in Milan some planking placed over the mouth of a dry well and covered with cultivated earth was removed by an electric discharge in such a way that the earth was precipitated bodily into the well. A lightning-conductor from a neighbouring building had its terminus in the well, where it is suggested that the explosion took place with the result described.—On the second derivatives of the potential functions of space, by G. Morera. A simpler method than that of Hölder (*Beiträge zur Potentialtheorie*) is here proposed for determining the existence of the second derivatives of the potential function of a mass distributed in a space of three dimensions.—The migrations of the tunny, by Prof. Pietro Pavesi. The commonly-accepted view that the true tunny (*Orcynus thynnus*, L.) is an oceanic fish migrating periodically from the Atlantic through the Strait of Gibraltar round the Mediterranean basin is shown to be erroneous. This fish is, on the contrary, essentially an inhabitant of the Mediterranean, where it migrates between the shallows in the spawning-season and the deep waters for the rest of the year, but rarely passing in large numbers beyond the Strait of Gibraltar.

Bulletin de l'Académie Royale de Belgique, March.—Memoir on bichlorureted alcohol, by Maurice Delacre. To ethylic alcohol, $CH_3—CH_2(OH)$, correspond the three chlorureted derivatives of alcoholic nature: (1) $ClCH_2—CH_2(OH)$; (2) $Cl_2CH—CH_2(OH)$; (3) $Cl_3C—CH_2(OH)$. The first of these having been determined by Würtz, and the third by Garzarolli-Thurnlack in 1881, the author has now succeeded in obtaining the second, resulting from the action of zinc-ethyl on anhydrous bichlorureted aldehyde, $Cl_2CH—CHO$. His description of the process adopted is accompanied by analytical data and experimental determinations leaving no doubt as to the nature of this compound.—On some derivatives of propane, by C. Winssinger. During his protracted studies of this substance the author has determined, contrary to the observations of Pierre and Puchot, the existence of a hydrate of propylic alcohol boiling at 87° C. He has also prepared in a pure state the sulphuret of orthopropyl with boiling-point 142° instead of the hitherto accepted 130° to 135°. He further shows that a solution of the organic hydrosulphates in alcohol is continuously decomposed during ebullition at contact with the alkaline hydrosulphates, yielding organic sulphur with liberation of hydrosulphuric acid. Lastly, he has determined some new compounds, such as the oxysulphide of propyl, which is dissolved at 14°·5 to 15°, and combines with the nitrate of calcium; a mono-orthopropylphosphoric acid, and a tri-orthopropylphosphoric ether. These substances are formed by the action of the pentachloride of phosphorus or orthopropylic alcohol, and have the respective formulas, $C_3H_7PO_4H_2$ and $(C_3H_7)_3PO_4$.—Researches on the localization and function of the alkaloids in plants, by MM. Errera, Ch. Maistriau, and G. Clautriau. For several years the authors have been engaged with the study of the alkaloids, especially in *Colchicum autumnale*, *Nicotiana macrophylla*, *Aconitum Napellus*, and various species of Narcissus. They have so far arrived at the general conclusion that the alkaloids are formed chiefly in the more active tissues where the albuminoids are incessantly decomposed and transformed. From these tissues the alkaloids gravitate towards the periphery, where they become more easily oxidized, and serve to protect the plant against attack. Physiologically they are analogous to the alkaloids developed in some animals, such as snakes, to an extraordinary degree; and must be regarded as the waste or refuse of the protoplasmic activity afterwards turned to account for protective purposes.

April.—Discovery of instruments of the Stone Age in the Congo State, by Ed. Dupont. Some specimens of rude implements are described, which have recently been discovered by Capt. Zboinski on the left bank of the Lower Congo in the region of the cataracts below Stanley Pool. They occurred in a district covered with chips of quartzite in the neighbourhood of South Manyanga, where this rock crops out, indicating the site of a former quarry or manufactory of such objects, such as have frequently been found in other parts of the world, but very seldom in Africa. They are unpolished, belonging to the Palæolithic epoch, the presence of which along the west coast of Africa has also been recently confirmed by similar finds, but in silex, in the Mossamedes district much further south.—On a case of chemical decomposition produced by pressure, by J. H. van 't Hoff and W. Spring. Under a pressure of 6000 atmospheres at a temperature of 40° C. the authors have succeeded in decom-

posing cuprico-calcic acetate which had previously been finely pulverized. The salt was slowly liquefied, and on the pressure being removed the surface of the instrument in contact with the salt was found covered with a coating of copper. Other experiments at lower and higher temperatures, but still much under the point of transition, showed that this substance is decomposed under the action of pressure, the process being accelerated according as the pressure and temperature are increased.—On forecasting the weather, by B. G. Jenkins. The author publishes a weather chart for London ranging over 62 years, showing, as he claims, that the moon not merely influences but is the actual cause of the weather, and consequently that it can be forecast by studying accurate barometric and thermometric readings recorded for a sufficiently lengthened period of time. He finds, for instance, that the readings for London for 1887 will be practically the same as those recorded for 1825, those for 1885 and 1886 corresponding in the same way with those for 1823 and 1824, and so on. He adds that in December last he issued a forecast for January 1887 based on the readings for January 1825, with the subjoined results:—Forecast: mean bar., 29·98; mean ther., 35°·5; rain, 1·5. Result: mean bar., 29·99; mean ther., 35°·9; rain, 1·3.

Notes from the Leyden Museum, vol. ix., No. 2, April 1887, contains, as usual, a large number of papers on entomology, and also a paper on a collection of mammals made at Mossamedes, from the pen of Dr. F. A. Jentink, the Director of the Museum. Mr. P. J. van der Kellen was one of the members of an Expedition to the Cunene River, which was commanded by Mr. Veth. On Mr. Veth's death, which took place very shortly on the Expedition reaching Mossamedes, Mr. van der Kellen determined himself to explore the district, and to make a collection of the fauna for the Leyden Museum. The country he is collecting in is, from a zoological point of view, unknown, and although none of the twenty-six species of Mammalia enumerated in this paper by Dr. Jentink are new to science, yet they form a most welcome addition to our knowledge of geographical distribution, and several of the forms are still very rare.

Engler's Botanische Jahrbücher, vol. viii. part 4, contains:—A contribution to the botanical geography of South Africa, by R. Marloth. This is a description of the plants growing in the south-west Kalahari district.—Contributions to the knowledge of the *Aponogetonaceæ*, by A. Engler. The chief conclusions arrived at are that the inflorescence of *Aponogeton* is not axillary in position, but two leaves and an inflorescence together form a collective whole, the inflorescence not being in the axil of either of them, but opposite the margin of one of the leaves: that in *A. distachyus*, which is the commonest cultivated species, the large white bract-like organ, which subtends each flower, is not a bract, but the single developed segment of the perianth: and finally that if the *Aponogetonaceæ* be united with the *Juncagineæ* and *Potamogetonaceæ* in the large family of *Najadaceæ*, the *Alismaceæ* should also be included in that family.—Then follows a condensed translation of the memoir on the vegetative organs of *Phylloglossum Drummondii*, by F. O. Bower, already published in the Trans. Roy. Soc., London: the chief result of this investigation is that as regards the vegetative organs, *Phylloglossum* appears to be a permanently embryonic form of Lycopod.—A list of plants found in West Greenland, together with remarks on their distribution, is contributed by Th. Holm, of Copenhagen, who accompanied the Danish vessel *Fylla* in its expeditions of 1884 and 1886.—The part closes with the continuation of the usual extracts from current literature.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, May 17.—Prof. W. H. Flower, F.R.S., President, in the chair.—The President read some extracts from a letter which he had received from Dr. Emin Pasha, dated Wadelai, November 3, relating to some skulls of the Chimpanzee from Monbottu, to some portions of the skeleton of individuals of the Akka tribe, and to some other objects of natural history which he had forwarded (*viâ* Uganda) to the British Museum of Natural History.—Mr. A. Thomson exhibited some specimens of a rare Papilio (*Papilio porthaon*) from Delagoa Bay, reared in the Society's Gardens.—Prof. Howes exhibited a drawing of a head of *Palinurus penicillatus*, received from M. A. Milne-Edwards, and remarked on the assumption of antenniform characters by the left ophthalmite shown in this specimen.—A paper was read by Mr. W. F. Kirby, Assistant in the Zoological Department, British Museum, entitled "A Revision of the Sub-family *Libellulinæ*, with descriptions of new Genera and Species." The last compendium of this group was published by Dr. Brauer in 1868, in which forty genera were admitted. Mr. Kirby now raised the number to eighty-eight, all fully tabulated and described in his paper, which likewise included descriptions of fifty-two new species. Mr. Kirby gave a short sketch of the characters of the *Libellulinæ*, and more especially of the neuration, which he considered to be of primary importance.—Mr. R. Bowdler Sharpe read the third part of his series of notes on the Hume Collection of Birds, which related to *Syrnium maingayi*, Hume, and to the various specimens of this Owl in the British Museum.—A communication was read from Mr. A. Smith Woodward, on the presence of a canal-system, evidently sensory, in the shields of Pteraspidian fishes. Mr. Woodward described a specimen which seemed to prove that the series of small pits or depressions upon the shields of these ancient fishes, observed by Prof. Ray Lankester, are really the openings of an extensive canal-system traversing the middle layer of the shield.—A second communication from Mr. A. Smith Woodward contained some notes on the "lateral line" of *Squaloraja*, in which it was shown that the "lateral line" of this extinct Liassic Selachian was an open groove supported, as in the Chimæroids, by a series of minute ring-like calcifications.

Anthropological Institute, May 10.—Mr. Francis Galton, F.R.S., President, in the chair.—Prof. Flower read a letter received by him from Emin Pasha, dated Wadelai, November 8, 1886.—Prof. Victor Horsley read a paper on the operation of trephining during the Neolithic period in Europe; and on the probable method and object of its performance. The paper was copiously illustrated by photographs of trephined skulls and of implements that may have been used in the operation. The fact that most of the holes are found in that part of the skull that covers the fissure of Rolando heightens the probability that the operation was performed as a remedy in cases of epilepsy, since the curve of brain-matter around that fissure is specially connected with what is known as cortical or Jacksonian epilepsy. It seems probable that the operation was, in the first instance, performed for depressed fractures of the skull, or for the traumatic form of epilepsy, and afterwards in other cases in which similar symptoms were observed.

Mathematical Society, May 12.—Sir J. Cockle, F.R.S., President, in the chair.—Prof. Anderson, Queen's College, Galway, was elected a member.—The following papers were read:—General theory of Dupin's extension of the focal properties of conic sections, by Dr. J. Larmor.—Sur une propriété de la sphère et son extension aux surfaces quelconques, by M. D'Ocagne.—On the motion of two spheres in a liquid, and allied problems, by Mr. A. B. Basset.—Second note on elliptic transformation annihilators, by Mr. J. Griffiths.

Chemical Society, May 5.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—A contribution to the study of well water, by Mr. R. Warington, F.R.S.—Crystals in basic-converter slag, by Mr. J. E. Stead and Mr. C. H. Ridsdale.—Note on the influence of temperature on the heat of dissolution of salts in water, by Dr. William A. Tilden, F.R.S.—The distribution of lead in the brains of two factory operatives dying suddenly, by Mr. A. Wynter Blyth. At a certain lead factory in the east of London five cases of more or less sudden death at different dates have been attributed to the effects of lead. In two of the cases the author had an opportunity of making a toxicological investigation. There has hitherto been no reasonable hypothesis to explain the profound nervous effects of the assimilation of minute quantities of lead, but if it is allowed that lead forms definite compounds with essential portions of the nervous system, it may then be assumed that in effect it withdraws such portions from the body; in other words, the symptoms are produced not by poisoning in the ordinary sense of the term, but rather by destruction—a destruction, it may be, of important nerve-centres.—Researches on silicon compounds and their derivatives: a new chlorobromide of silicon, by Dr. J. Emerson Reynolds, F.R.S. In purifying a large quantity of silicon tetrabromide prepared by means of crude bromine, the author has separated a portion boiling at 140°–141°, of the relative density 2·432, which analysis shows to be the chlorobromide of the formula $SiBr_3Cl$.

May 19.—Mr. Wm. Crookes, F.R.S., President, in the chair. —The formation of hyponitrites, by Prof. Dunstan and Mr. T. S. Dymond.—Ozone from pure oxygen, by Mr. W. A. Shenstone and Mr. J. Tudor Cundall.—The volumetric relations of ozone and oxygen: a lecture experiment, by Mr. W. A. Shenstone and Mr. J. Tudor Cundall. Soret and Brodie have shown that if v be the contraction produced on the electrification of a mass of oxygen, then $2v$ will represent the further contraction that will occur on absorbing the ozone formed by means of turpentine. If it be true that ozone completely dissolves in turpentine, this indicates that three measures of oxygen are concerned in the formation of two measures of ozone. The authors describe an apparatus which they have constructed for readily exhibiting Soret's observations to a class. The President said that he had been accustomed to join tubes *in situ* in the manner described by Mr. Shenstone. He added that it was possible to join together two different kinds of glass by means of a little soft white enamel, such as could be obtained from Powell's. Mr. Fairley had also joined tubes in the manner described by the authors; calling attention to Brodie's ozonizing apparatus, he remarked that the tube used by Brodie was probably thinner than was used by the authors. Dr. Armstrong thought that the results of the authors' experiments on the action of mercury on ozone were a valuable contribution to our knowledge of the influence of minute amounts of third bodies on the course of chemical change. He suggested that it was important, if possible, to determine the extent to which oxidation took place in presence of varying minute amounts of moisture, in order to ascertain if this exercised an influence comparable with that exhibited in Prof. H. B. Dixon's experiments on the rate of propagation of the explosive wave in a mixture of carbonic oxide and oxygen. Mr. Shenstone said that experiments such as were suggested by Dr. Armstrong, although very difficult with mercury, might probably be carried out with silver, which effected the decomposition of ozone with extraordinary facility. In reply to the question put by Mr. Page, he was quite unable to account for the peculiar condition assumed by the mercury when submitted to the action of the ozone. He had not been successful in joining tubes with the aid of the enamel spoken of by the President, but on the other hand had found it easy to join even combustion tubing to soft glass by means of an oxyhydrogen jet. —On the thermal phenomena of neutralization and their bearing on the nature of solution and the theory of residual affinity, by Mr. S. U. Pickering.—The action of metallic alkylates on mixtures of ethereal salts and alcohols, by Prof. T. Purdie.

Royal Meteorological Society, April 20.—Mr. W. Ellis, President, in the chair.—The following papers were read:—The storm and low barometer of December 8 and 9, 1886, by Mr. C. Harding. This gale will long be remembered as the one in which twenty-seven lives were lost in the lifeboat disaster off Formby through the capsizing of the Southport and St. Anne's lifeboats. The violence of the storm was felt over the whole of the British Islands as well as over a great part of the Continent of Europe, the force of a gale blowing simultaneously from Norway to Spain. The strongest force of the gale in the United Kingdom was experienced in the west and south-west, and the highest wind force recorded by any anemometer over the country was a velocity of eighty miles in the hour registered at Fleetwood, whilst at Valentia, Scilly, and Holyhead, the velocity reached seventy miles in the hour. The most exceptional feature of the storm was the extraordinary low reading of the barometer and the long time that the mercury remained at a low level. The absolutely lowest authentic reading was 27·38 inches at Belfast, and the barometer fell below 28 inches over a great part of England, Scotland, and Ireland. At Aberdeen the mercury was below 28 inches for eighteen consecutive hours, and below 29 inches for more than sixty hours, whilst in the north of England the barometer readings were equally exceptional.—Report of the Wind Force Committee, drawn up by Mr. G. Chatterton. In this Report, which is a preliminary one, the Committee have dealt mainly with that portion of the investigation relating to Beaufort's scale of wind force and the equivalent velocity in miles per hour.—A new form of velocity anemometer, by Mr. W. H. Dines. In this instrument an attempt has been made to measure the velocity of the wind by the rotation of a small pair of windmill sails, the pitch of the sails being altered automatically, so that the rate may always bear the same rates to that of the wind.—Description of two new maximum pressure registering anemometers, by Mr. G. M. Whipple.

May 18.—Mr. W. Ellis, President, in the chair.—The following papers were read:—Brocken spectres and the bows that often accompany them, by Mr. H. Sharpe. The author has collected all the original descriptions of the Brocken spectre, which is really the shadow of the observer cast by the sun upon clouds. In some cases the shadow is surrounded by a bow, which the author shows is like the rainbow in colour and in the order of colours. The head of a shadow is sometimes surrounded by another sort of phenomenon touching the head, and which the author names the "glory."—Results of thermometrical observations made at 4 feet, 170 feet, and 260 feet above the ground at Boston, Lincolnshire, 1882–86, by Mr. W. Marriott. These observations were made on Boston Church tower which rises quite free from any obstructions, in a very flat country, to the height of 273 feet. A Stevenson screen with a full set of thermometers, was placed 4 feet above the ground in the churchyard, a similar screen and thermometers was fixed above the belfry at 170 feet above the ground, while a Siemens electrical thermometer was placed near the top of the tower, the cable being brought down inside and attached to a galvanometer on the floor of the church, where the indications were read off. The results showed that the mean maximum temperature at 4 feet exceeds that at 170 feet in every month of the year, the difference in the summer months amounting to 3°; while the mean minimum temperature at 4 feet differs but little from that at 170 feet, the tendency, however, being for the former to be slightly higher in the winter and lower in the summer than the latter. As the electrical thermometer was read usually in the day-time, the results naturally showed that the temperature at 4 feet during the day hours was considerably warmer than at 260 feet. The author, however, detailed several sets of readings which had been made during the night as well as the day, the results from which were of a very interesting character.—Snowstorm of March 14 and 15, 1887, at Shirenewton Hall, near Chepstow, by Mr. E. J. Lowe, F.R.S.—During the evening the President made a presentation to Dr. J. W. Tripe of a silver tea and coffee service, which had been subscribed for by the Fellows in acknowledgment of the many services which he had rendered to the Society during a period of over thirty years.

EDINBURGH.

Royal Society, May 16.—Lord Maclaren, Vice-President, in the chair.—Prof. D'Arcy W. Thompson read a paper on the blood of *Myxine*, and also a paper on the larynx and stomach in *Cetacea*.—Mr. W. Peddie read a paper on the increase of electrolytic polarization with time; and another on transition-resistance at platinum electrodes, and the action of condensed gaseous films. He showed that such resistance exists; that it gradually increases with the lapse of time after heating the plates to redness; and that it is due to the condensation of gas on the surface of the electrodes. The specific resistance of the condensed gases is probably of the same order as the specific resistance of ordinary dielectrics.—Prof. Crum Brown communicated a paper by Dr. A. B. Griffiths on the problematical organs of the Invertebrata, especially those of the *Cephalopoda*, *Gastropoda*, *Lamellibranchiata*, *Crustacea*, *Insecta*, and *Oligochæta*.—Mr. J. T. Cunningham gave an account of the nephridia of *Lanice conchilega*, Malmgren.—Prof. Tait informed the meeting that M. Amagat has succeeded in solidifying tetrachloride of carbon by pressure alone.

PARIS.

Academy of Sciences, May 23.—M. Janssen in the chair. —Obituary notices of the late M. Vulpian, by M. Bertrand, in the name of the Academy, by M. Charcot on behalf of the Section for Medicine and Surgery, and by M. Brown-Séquard on behalf of the Biological Society.—A general method of determining the constant of aberration, by M. Lœwy. At the moment of observation, when the two couples of stars are at the same height above the horizon, their common altitude, h, is determined by the formula:

$$\sin h = \cos \frac{\Delta}{2} \cos \frac{\Delta'}{2}.$$

Then, this quantity being known, a complete answer may be given to the questions as to the most rational values to be adopted for Δ and Δ' in order to obtain the greatest effect of aberration. —On the different states of tellurium, by MM. Berthelot and Ch. Fabre. It is shown that in passing from the amorphous to the crystalline state this element absorbs a certain quantity of heat; also that the precipitated tellurium, whether in presence of an alkaline liquid or an excess of hydrotelluric acid, corresponds to the state of the crystallized tellurium, but when precipitated by sulphurous acid it is altogether or mainly amorphous.

The same phenomena have been observed with sulphur, showing a parallelism between the states of these two substances under the physical or chemical conditions determining those states.—Method for determining the specific activity of the intra-muscular exchanges, or of the coefficients of the nutritive and respiratory activity of the muscles in repose and at work, by M. A. Chauveau. The author here describes the technical processes adopted in carrying out the experiments, the results of which have already been communicated.—The earthquake of February 23, by M. Albert Offret. A summary description is given of all the seismic apparatus affected by the disturbance. With very few exceptions all those within the whole area of the earthquake yielded some indications, the interpretation of which is reserved for future consideration.—On the history of the Phylloxera of the vine, by M. P. de Lafitte. The existence is denied of the two distinct species determined and described in a recent communication by M. Donnadieu under the names of *P. vastatrix* and *P. pemphigoides*.—On Cremonian quadratic groups, by M. Autonne. Having in a previous paper considered the properties of an isolated quadratic Cremonian, the author here explains how such substitutions combine together to form Cremonian quadratic groups.—On a means of regulating and gauging the discharge of open canals, by M. H. Parenty. A theoretic solution is given of various problems connected with the discharge of open canals, with the view of determining automatically the quantity of water supplied in a given period, the total discharge at a given moment, the proportional discharge from one artery through several diverging rills, and similar questions.—On a general law for the vapour-tensions of dissolvents, by M. F. M. Raoult. By the researches here described the author arrives at the general law that one molecule of a non-saline fixed substance by its solution in 100 molecules of any volatile liquid diminishes the vapour-tension of that liquid by a nearly constant fraction of about 0·0105 of its value. The law is completely analogous to that announced by the author in 1882 regarding the lowering of the freezing-point of dissolvents.—On the compressibility of cyanogen compared with its refraction, by MM. J. Chappuis and Ch. Rivière. In order to complete their studies on the refraction of cyanogen and the comparison of the measured indices with the corresponding specific weights, the authors have undertaken the present researches on the compressibility of this gas, on which only a few imperfect data were incidentally supplied by Regnault.—On the polarization of copper by the extension of its surface in contact with a conducting fluid, by M. Krouchkoll. Lippmann having determined the polarization of mercury by increasing its surface in contact with a conducting fluid, the author has made a series of studies to ascertain whether the same phenomenon applies to the solid metals and to certain organic expansive substances, such as gelatine and coagulated albumen. The present note is confined to the study of copper in contact with distilled water, and with water containing 2 per cent. of ordinary sulphate of soda. The results of experiments with other ductile metals are reserved for a future communication.—Note on a stroke of lightning, communicated by the Minister of Posts and Telegraphs. A series of phenomena are described, which occurred during a thunderstorm at Mortrée (Orne), on April 24. Fragments of incandescent stones fell in large quantities, some about the size of a walnut, of a grayish-white colour, which crumbled between the fingers, emitting a distinct smell of sulphur. The others, which were of smaller size, looked exactly like coke. Some plaster was also detached from the front of a neighbouring house and transferred to the window of a house on the opposite side of the street. During another storm, on May 13, great havoc was done by the electric fluid at Eza (Maritime Alps), where it made a broad and deep fissure 20 metres long in the side of the mountain, detaching a solid mass measuring several hundred cubic metres.

BERLIN.

Meteorological Society, May 3.—Professor von Bezold, President, in the chair.—Dr. Schultz spoke on the contrast between the popular names given to meteorological phenomena and their real nature as determined by means of instruments. Thus, for instance, the sirocco wind in Italy is spoken of as "heavy," whereas the barometer indicates a diminished pressure. Summers are spoken of as wet and dry, according as they are accompanied by much or little rain, without taking into account the usually opposed indications of the psychrometers; similarly our sensations of heat and cold are often directly opposed to the indications of the thermometer. The speaker further brought forward meteorological observations which he had made in Rome and the Riviera, and which showed occasionally, among other things, the anomaly that the temperature in the shade was higher than in the sun, especially when the thermometer in the sun was exposed to a strong wind. In the course of the elaborate discussion which followed upon the above communication, the President explained the larger part of the anomalies which had been described, and laid stress upon the difference between physical meteorology and the influence of temperature and moisture on the living organism. Alterations of atmospheric pressure have no effect on healthy human beings, although they must on sickly people, inasmuch as a diminution of pressure must lead, as a consequence, to an increased evolution of gases from the soil, and their accompanying miasmas. The idea of sultriness has not as yet been defined from a physical point of view; probably in connexion with this it should be borne in mind that the air is occasionally supersaturated with aqueous vapour, as shown in the experiments of Robert von Helmholtz, and that in this case a commencing condensation may be accompanied by a real evolution of heat. Prof. Schwalbe explained the conditions as to dampness, which had been brought forward by the speaker. Dr. Assmann explained, in connexion with this communication, an experiment which he had made with a view to determining the real temperature of the air, and which had given good results. The bulb of the thermometer was surrounded by a very perfectly reflecting cylinder of polished silver open below and closed above, but communicating by a lateral tube with an aspirator: by this method the air was drawn past the bulb of the thermometer in a constant current, while at the same time all external heat is prevented from reaching the thermometer by means of the reflecting cylinder. This thermometer indicates exactly similar temperature, both in the sun and in the shade. In conclusion, Dr. Sklarek mentioned experiments on the radiation of heat from the human body, which showed, in opposition to the laws of radiation from non-living bodies, that the human body radiates more heat from exposed parts of its surface, which are usually covered with clothes, when the difference of temperature between the skin and the surroundings is less than when it is greater. This anomalous behaviour may be explained by the supposition that, when the difference of temperature (between the skin and the surroundings) increases, the physical properties of the skin and its radiating powers undergo some change.

Physical Society, May 6.—Prof. Du Bois-Reymond, President, in the chair.—Dr. König spoke on Newton's law of the mixing of colours (see report on the meeting of the Physiological Society of April 29). In connexion with this, Prof. von Bezold communicated the fact that he had observed during his experiments on the mixing of colours, so-called neutral points in the spectrum, not merely when working with dichromatic, but also with normal trichromatic eyes. When, for instance, the intensity of a spectrum is greatly diminished (this may be most simply brought about by inserting a diaphragm with a small opening into the collimator) and a direct-vision spectroscope is used, then only three colours are seen at all—namely, red, green, and violet: between red and green and between green and violet there are neutral points. If the intensity of the light is still further diminished, then the neutral points undergo a change of position; the red extends to beyond the line D, and the neutral point at the line F moves in the opposite direction. This last fact was no longer recollected with any great exactness by the speaker, inasmuch as the experiments had been made many years ago, but the moving of the neutral point near D towards the green he described as existing without doubt. This appearance of the spectrum of light of small intensity was regarded by Prof. von Bezold as a proof of the truth of the Young-Helmholtz theory of colours. A second observation had reference to the mixing of colours with white. According to the Newton-Grassmann theory of the mixing of colours, every spectral colour, when mixed with white, must maintain its "tone" in the sense of the word as used by the French; this observation has, however, shown that not only red, but also violet, if mixed with white, takes on a purplish tone.—Prof. von Bezold made a further communication to the effect that Dr. Sprung had observed a series of notches on the curve of his barograph between six and seven o'clock on the morning of May 3, without any thunderstorm having taken place: the curves of a Bourdon aneroid barometer, and of the barograph at the Landwirthschaftliche Hochschule, showed the same irregularities. This irregularity of the curve of atmospheric pressure repeated itself on the morning of May 4 between 3 and 4

o'clock, but this time it coincided with a thunderstorm. The irregularity of the atmospheric pressure on May 3 acquires an especial significance, on account of the telegraphic news of the serious eruptions which took place in Mexico and California on the same day, although the time of the eruption is not yet definitely fixed. As a matter of fact, the barographic curve of May 3 shows a great resemblance to that observed at the time of the outbreak of Krakatão on August 27, 1883; the speaker produced the latter curve for comparison. It is not altogether impossible that the variation of atmospheric pressure on May 3, and possibly that of May 4, may have been in some way connected with the eruptions in America at the same time.

Physiological Society, May 13.—Prof. Du Bois-Reymond, President, in the chair.—Dr. Joseph communicated the results of his anatomical researches on the physiology of the spinal ganglia. According to Waller's older experiments, section of the nerves between the spinal cord and ganglion produces a degeneration of the central part of the nerve, whereas section of the nerve on the other side of the ganglion leads to a degeneration of all the sensory nerve-fibres up to the section. In 1883, however, a pupil of Gudden raised an objection to these experiments, since he found that, by removal of the connecting portion (between the cord and ganglion), not only the central but also the peripheral part of the nerve degenerated. Dr. Joseph has repeated these experiments on cats, and has arrived at the following results, which agree with those which Krause has recently communicated to the Society (see NATURE, May 12, p. 48). Thus (1) There are a number of nerve-fibres which simply pass through the ganglion without being connected with its cells. (2) The ganglion is the trophic centre for the larger number of sensory nerves. (3) The ganglion-cells are bipolar.—Dr. Lewin has examined a series of specimens of urine which contained blood, and were obtained from widely different cases, and found that most of them contained methæmoglobin, as shown by its characteristic spectrum. When these specimens of urine were reduced by means of sulphide of ammonium, he did not obtain the well-known spectrum of reduced hæmoglobin which is always obtained when blood which contains methæmoglobin is reduced; but in many cases he observed the no less well characterized spectrum of reduced hæmatin. It seems to follow from this that the urine of certain patients may contain hæmatin.—Prof. Zuntz gave an introductory explanation of an experiment which was subsequently carried out by Prof. Wolff, to show, namely, that anyone can diminish his weight by taking a deep inspiration. This experiment is most striking when the subject stands on a decimal balance which is so arranged that it can only give a kick upwards; in this case the pan with the weights in it sinks when a deep inspiration is taken. The speaker explained this phenomenon as being the result of the sudden straightening of the spinal column and elevation of the head which occurs when the deep inspiration is taken; owing to its momentum, the head carries the lower part of the body slightly with it, so that the latter presses less forcibly on its support.

STOCKHOLM.

Royal Academy of Sciences, April 13.—On the Lias of the province of Scania, in the south of Sweden, by Dr. J. C. Moberg.—A theory of unipolar induction, by Prof. E. Edlund.—Report on a visit to the United States and Canada for the purpose of studying the fisheries of those countries, by Dr. F. Trybom.—On the structure of the pericarp in the Boragineæ, by Miss A. Olbers.—On the development of the secondary fibro-vascular bundles in Dracæna and Yucca, by Miss H. Lovén.—A suggestion respecting the theory of the constant electric currents, by Dr. A. Rosén.—A crystallographic study of two new hydro-carbons, by Herr M. Bäckström.—Observations on natural phenomena of corrosion, and new faces of crystals in Adular from Swarzenstein, by Dr. A. Hamberg.—On tetartohedrism in tourmaline, by Dr. W. Ramsay.

May 11.—Contributions to a monograph of the amphipoda Hyperiidea, by Dr. C. Bovallius; part 1, the families Tyronidæ, Lanceolidæ, and Vibilidæ.—On the recent Astrophotographic Congress in Paris, by Prof. Hugo Gyldén.—On a group of differential equations, the solution of which is combined with so-called small divisors, by Dr. C. Bohlin.—On the results of the determinations of the longitude between Stockholm, Gothenburg, and Lund, undertaken during 1885 and 1886, by Prof. Rosén.—On the levellings conducted during 1886, by the same.—On the interior friction of dilute aqueous solutions, by Dr. S. Arrhenius.—Contributions to the knowledge of the changes of steel in physical respects when it is softened, by Herr C. F. Rydberg.—On the diffusion of radiating heat from spherical surfaces, by Dr. K. Ångström.—On the electric resistance against conductibility in crystals, by Herr H. Bäckström.—On acollection of Coleoptera and Lepidoptera from the Congo, made by Lieut. Juhlin-Dannfelt, and described by Prof. C. Aurivillius.—The following papers by Prof. Nilsson and Dr. G. Krüss, of Munich, were presented:—On the equivalent and atomic weights of thorium.—On the earths and the niobic acid in fergusonite.—On the product of the reduction of niobfluorkalium with natrium.—On the German fluoride of kalium.—Studies on Taphrina, by Dr. C. J. Johansson.—On the species of Echinoidea, described by Linnæus in his work "Museum Ludovicæ Ulricæ," by Prof. Sven Lovén.—On some definite integrals, by Dr. Lindman.—On organic sulph-amido-combinations, by Prof. Cleve.—On naphthydroxam acids, by Dr. A. G. Ekstrand.—On the crystals of some combinations of zirconium, by Dr. M. Weibull.—*Lagopus bonasioides*, a hybrid between *Lagopus subalpina* and *Tetrao bonasia*, by Herr G. Kolthoff, Conservator of the Zoological Museum of Upsala.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Cartilla de Zoologia Evolucionista: M. R. Mexia (Jacobsen, Buenos Aires).—The Health of Nations, 2 vols.: B. W. Richardson (Longmans).—Proceedings of the Bath Natural History and Antiquarian Field Club, vol. vi. No. 2 (Bath).—La Matière et l'Energie: E. Ferrière (Alcan, Paris).—Life of Charles Darwin: G. T. Bettany (Scott).—Report of the Commissioner of Education for 1884-85 (Washington).—Illustrations of the British Flora: Fitch and Smith (Reeve).—Essays and Addresses: Rev. J. M. Wilson (Macmillan).—Climatic Treatment of Consumption: Dr. J. A. Lindsay (Macmillan).—Elementary Practical Histology: W. Fearnley (Macmillan).—Alcyonida: D. C. Danielssen (Grondhal and Son).—A New Basis for Chemistry: T. Skerry Hunt (Trübner).—Sketches of Life in Japan: Major H. Knollys (Chapman and Hall).—Cosmogonie: C. Braun (Münster).—Beiträge zur Kenntnis der Nosean-führenden Auswurflinge des Laacher Sees (Hölder, Wien).—Annalen der Physik und Chemie, No. 6, 1887 (Leipzig).

CONTENTS.

	PAGE
The Pre-History of the North. By **Dr. John Evans, F.R.S.**	97
Professor Stokes on Light. By **Prof. P. G. Tait**	98
Our Book Shelf:—	
Wood: "Our Bird Allies"	99
Letters to the Editor:—	
Thought without Words.—**Prof. F. Max Müller; Francis Galton, F.R.S.**	100
A Use of Flowers by Birds.—**J. M. H.**	101
Earthquakes and the Suspended Magnet.—**Dr. M. A. Veeder**	102
Units of Weight, Mass, and Force.—**I. Lancaster; Prof. D. H. Marshall**	102
Remarkable Phenomenon seen on April 26, 1887.—**E. J. Lowe, F.R.S.**	102
Pear-shaped Hailstones.—**B. Woodd Smith**	102
"A Junior Course of Practical Zoology."—**G. B. H.**	102
Bishop's Ring.—**T. W. Backhouse**	102
A Review of Lighthouse Work and Economy in the United Kingdom during the Past Fifty Years. I. By **J. Kenward**	103
Condensation of Gases. By **A. E. Tutton.** (*Illustrated*)	105
A Recent Japanese Earthquake. By **Prof. J. A. Ewing.** (*Illustrated*)	107
Notes	109
Our Astronomical Column:—	
The Paris Observatory	112
Astronomical Photography	113
Comet 1887 *e* (Barnard, May 12)	113
Astronomical Phenomena for the Week 1887 June 5-11	113
Geographical Notes	113
The Iron and Steel Institute	114
The Institution of Mechanical Engineers	114
Note on the Spectrum of Didymium. By **Dr. Claude M. Thompson**	115
University and Educational Intelligence	115
Scientific Serials	115
Societies and Academies	117
Books, Pamphlets, and Serials Received	120